GM4000QCI
EQUATORIAL GERMAN MOUNT
Instruction and Maintenance User's Manual

REV. 5.3 – July, 2010

Firmware version 2.7.2

Parts of this manual are translated from a manual in German language created by Helmut Heinicke, Nersingen.

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1 Foreword

1.1 Aim of this Manual

In accordance with the provisions of the European Machinery Directive 89/392/EEC, as amended by 91/368/EEC and 93/44/EEC, and of Directive 89/833/EEC, our company has developed this instruction and maintenance manual, in order to inform all users about the product, the correct methods of interaction with the machinery, in order to guarantee optimum safety conditions for people, animals and things, during its entire life cycle: transport, storage, installation, usage and maintenance.

1.2 Ownership and Importance of this Manual

This manual is an integral part of the machine. We therefore advise users to keep it in a safe place for the foreseeable duration of the product itself. It is the client's responsibility to transfer this manual to possible subsequent owners of the machine, or to any one else who will possess or make use of the machine.

1.3 Updating of this Manual

In the event of improvements and/or corrections being made to the machine, either by the manufacturer or by the client, subject to written authorisation by the manufacturer, it might be necessary to also update the documentation of the manual. Our company will evaluate this necessity, case by case, and will dispatch the modified parts of the manual. Our company will also indicate, by sending updates, all the sections of the manual to be disposed of, specifying the dates of validity of the modifications and the revision number of the manual's edition. The receiver is obliged to comply scrupulously with the provisions stipulated by the manufacturer in order to ensure that all copies of the manual, distributed within the company, are updated to the latest edition. It is strictly forbidden to make changes of any nature or any type whatsoever, to the contents, the graphic layout and the structure of the manual.

Furthermore, our company reserves the right to improve the product through modifications even though they may not be described in this edition of the manual.

Furthermore, our company also reserves the right to change or update this manual.

2 Technical Data

Weight	120kg without accessories
Maximum load	~ 150kg
Optimum useful load	~ 125kg
Latitude range	23° – 70° adjustable with screw
Azimuth fine adjustment range	+/– 10° adjustable with double screws
Counterweight shaft	60mm diameter stainless steel, weight 13kg
Counterweights (optional)	26kg each, plated steel, 30µm nickel coating
R.A. axis diameter	85mm
Declination axis diameter	80mm
Material	alloy steel

Note: the axis have holes of 60mm diameter to allow the insertion of connecting cables.

Bearings	130mm diameter, multiple roller conical
R.A. worm wheel	330mm diameter, 430 teeth, bronze B14
Declination worm wheel	244mm diameter, 315 teeth, bronze B14
Worm	32mm diameter, tempered alloy steel
Transmission system	backlash-free system with belt and automatic backlash recovery
Distance between pier axis and declination axis	about 125 mm – optionally 250 mm for long refractors
Motors	2 axes A.C. servo brushless F.I.S.
Power supply	24VDC
Power consumption	~ 1.5A while tracking ~ 5A at maximum speed
Control system	QCI
Guide speed	Adjustable from 0.1x to 1x
Go-to speed	4°/s max. R.A., 5°/s max. declination
Pointing accuracy	<1' (mechanical average error) <30” with internal 25-stars software mapping
Mean tracking precision	+/– 3”/4” typical without PEC

3 Introduction

The GM4000QCI German equatorial mount has been designed for a professional utilisation, to meet the needs of the advanced observer who requires a mount with maximum strength and rigidity. It will satisfy the professional observer and photographer wanting to obtain very good results. The GM4000QCI is the perfect mount for big instruments in the observatory, carrying 300mm refractors, 400mm Newtonian reflectors, 500mm Cassegrains...

Born from the needs and experience of astronomers, inspired from the traditional German form, the GM4000QCI mount has been designed completely in Italy with innovative technologies, such as 3D-CAD models and CAM, and manufactured using modern CNC machine tools with high precision, carved out from aluminium bar-stock.

Other features comprise the QCI control system with sophisticated servo motors on both axes and industrial electronics, and a system of bored axes to put all cables inside the axes of the mount. The electronics and all the electric connections are integrated in a box mounted directly on the R.A. axis body that can be easily removed for maintenance.

All this is a warranty of success.

In order to maximise your pleasure on your first night of observation, we recommend that you familiarise yourself with the assembly and basic operation of the mount.

Look at the illustrations and read the manual.

Please take particular note of counterbalancing, operation of the keypad controller, a correct utilisation of your new mount and this caution:

DANGER

Never look at the Sun with a telescope or finderscope without installing a proper and secure solar filter. Looking at the Sun without a secure solar filter compromises the eye instantaneously and without remedy. Before looking at the Sun it is necessary to install securely a proper solar filter.
Don’t use filters mounted at the eyepiece. Optics could be damaged by the excessive heat, and some filters can break!
Never use your telescope/mount system to project an image of the sun onto any surface; internal heat build-up can damage the telescope.
Particular attention is required when observing in daytime without filter (Venus, for example). Never look through the telescope or the finder when the mount is slewing.
Never look at an object too near to the Sun.
Never leave unattended your telescope if it is able to point at the Sun.
Never leave the telescope system unsupervised, when unauthorised persons or children are present.

GOOD OBSERVATIONS TO YOU.

4 Mount Setup

4.1 Standard Configuration Items

Ordering a GM4000QCI in the standard configuration you receive the following items:

1. equatorial mount GM4000QCI (assembled) with attached control box;
2. base adapter;
3. azimuth adjustment block;
4. azimuth adjustment block screws (x2);
5. mount locking screws (x6) and washers (x6);
6. counterweight shaft;
7. hand pad;
8. power supply cable;
9. GPS to serial adapter cable;
10. remote switch cable;
11. CD-ROM with maintenance and instruction manual and software.

Fig. 4.1: Standard configuration items.

Depending on the packaging type, some items may come already assembled – in particular, the azimuth adjustment block and screws (3 and 4) can be already

assembled with the base adapter (2); the base adapter (2) can be already assembled with the mount (1); the mount locking screws and washers (5) can be already assembled with the mount.

When you receive your new GM4000QCI mount, pay attention to check that no part has been damaged during shipment; damaged parts may not work correctly and may damage the system.

This equipment must be considered like a **precision instrument!**

4.2 Required Tools

In order to assembly your mount and make the necessary adjustments, you need the following tools:

combination spanners in the following sizes:
8mm – 13mm – 15mm – 17mm

hex (Allen) screwdrivers in the following sizes:
2.5mm – 3mm – 4mm – 5mm – 6mm – 8mm – 10mm

4.3 Packaging and Handling

The mount can be shipped to you in a case (Fig. 4.2) or on a pallet (Fig. 4.3).

Fig. 4.2: Mount shipped in a case.

Fig. 4.3: Mount shipped on a pallet.

If the mount came on a pallet, you will have to unscrew the retaining bolts under the pallet.

When shipping the mount again, use the original packages.

4.3.1 Handling the Mount

Whenever you need to move the mount around, use the points highlighted in Fig.

4.4 to attach the belts or chains of the transportation system. Use this procedure:

1. Before moving the mount, ensure that no counterweights or telescope are mounted.
2. Unhook both the worm gears following the procedure described in paragraph 4.5, steps 1 to 5.
3. Move the mount to its final position.
4. Engage again the worms following the procedure described in paragraph 4.5, steps 7 to 12.
5. Remove the belts.

Fig. 4.4: Attach points.

WARNING

Moving the mount without unhooking the worm gears can result in damage to both the worms and the worm wheels. This would compromise the performance of the mount. Always remember to unhook the worm gears when you move the mount.

4.1 Attaching the Mount to the Pier

The GM4000QCI is mounted on a pier by means of the base adapter (Fig. 4.5). The pier's top must be machined as shown in Fig. 4.6 in order to provide a suitable housing for the base adapter, keeping the correct orientation. Please refer to the base adapter technical drawing in Appendix B.

If the base adapter (Fig. 4.1, n.2) is not already assembled with the azimuth block and screws (Fig. 4.1, n.3 and n.4) begin by assembling them.

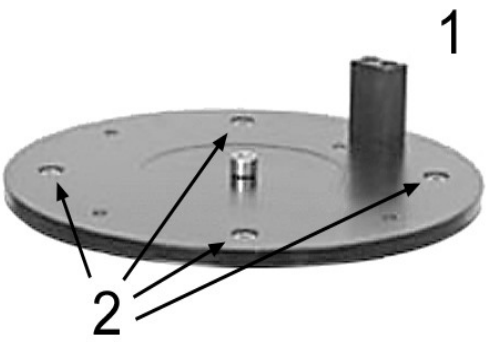


Fig. 4.5: Base adapter.

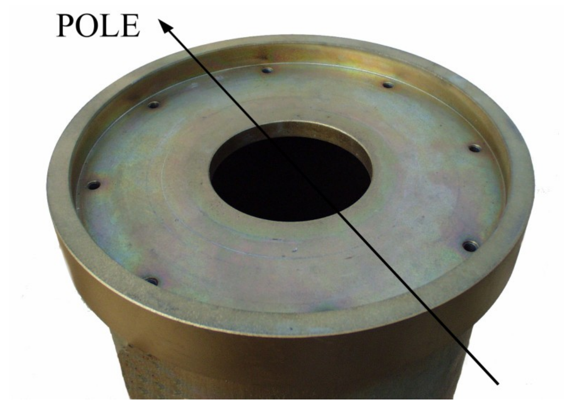


Fig. 4.6: Pier's top.

The protruding block (1) of the base adapter is used for azimuth alignment and should be oriented away from the celestial pole (i.e. towards south if you are in the northern hemisphere, and towards north if you are in the southern hemisphere). The base adapter has to be screwed to the pier using eight bolts (2).

Instead of machining the pier's top to accommodate the base adapter, you can use the optional pier adapter (Fig. 4.7). In this case, the flat top of the pier should accommodate the eight bolts used to fix the pier adapter to the pier; then you can mount the base adapter on the pier adapter.

Please refer to the pier adapter technical drawing in Appendix B.

Fig. 4.7: Pier adapter (optional).

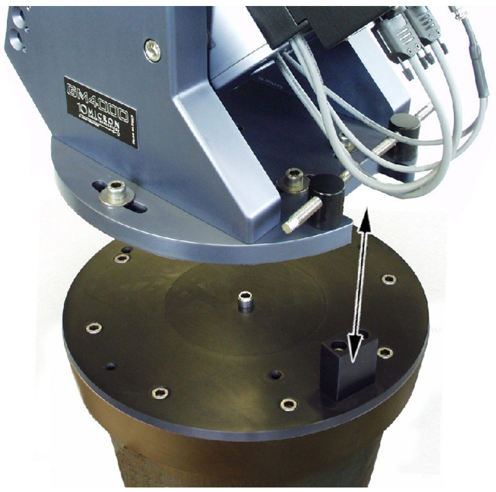


Fig. 4.8: Mount and base adapter alignment.

After locking the base adapter, put the mount on it paying attention to align the azimuth adjustment screws on the mount with the protruding block on the base adapter (Fig. 4.8). Then lock the six screws holding the mount to the base adapter.

4.2 Rough Altitude Adjustment

The altitude of the R.A. axis must match the latitude of your observing site. Refer to Fig. 4.9 for locating all the relevant parts of the mount.

We recommend that you do the rough altitude adjustment before mounting the counterweights and the telescope, since you will be making major adjustments to the position of the mount at this time. The telescope and the counterweights would add considerable weight and require more effort.

The support bar (1) must be locked in the appropriate position using the holes (2)

according to the following table:

latitude	position
from 54° to 70°	1st hole (top position)
from 42° to 54°	2nd hole
from 32° to 42°	3rd hole
from 23° to 32°	4th hole (bottom position)

In the picture the support bar is located in the 2nd hole.

The support bar is held in position by two screws; two smaller screws (orientation screws) located in the small holes (3) are used to put the altitude screw (4) orthogonal with the plane under the R.A. axis body.

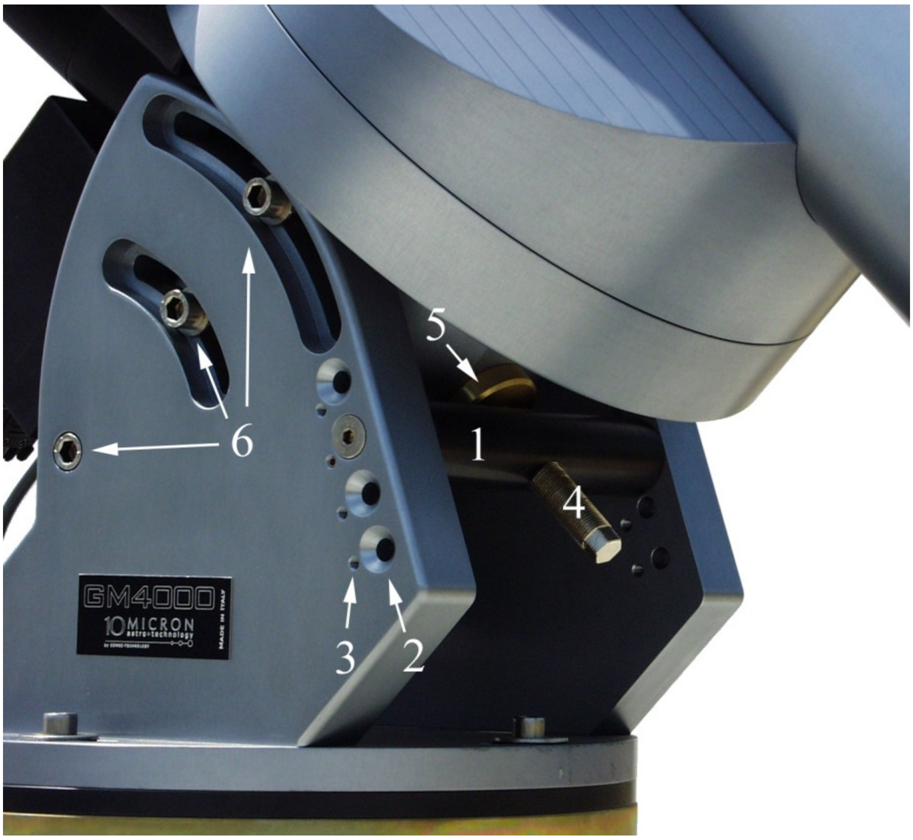


Fig. 4.9: Altitude adjustment system.

In order to change the position of the support bar the following procedure should be applied:

1. make sure that no instrument nor counterweights are mounted;
2. loosen about one turn the six altitude locking screws (6) supporting the R.A. axis body;
3. locate the R.A. axis body high enough to leave some space to put the support bar in the correct position and lock the six altitude locking screws;
4. loosen and remove the two screws holding the support bar and the two smaller orientation screws;
5. move the bar in the new position and insert the two bigger screws, without locking them;
6. insert the two smaller orientation screws paying attention to centre the hole in the support bar; when you arrive to the bottom, turn back one turn.

These screws give automatically an orthogonal inclination to the altitude screw with the plane under the R.A. axis body;

7. put the brass disk (5) between the altitude screw and the R.A. axis body; turn the the altitude screw until the disk touches the R.A. axis body;
8. lock the two big screws holding the support bar;
9. lock the six altitude locking screws.

Later, you will do your final polar alignment with the telescope and counterweights.

4.3 Insertion of cables

The GM4000QCI mount bored axes have an inner diameter of 60mm, allowing insertion of additional cables as required by your application. The hole in the declination axis can be reached through a window under the “GM4000” plaque on the declination axis body (Fig. 4.10). It is better to insert all cables before mounting the telescope, because the telescope assembly is likely to block or impair the access to the declination axis hole.

Start from the hole in the R.A. axis, accessible from the bottom of the mount (Fig. 4.11); then, operating from the window in the declination axis body (Fig. 4.12), take the cable end and insert it into the hole in the declination axis, until it comes out of the telescope flange. The cables should rest in the groove in the telescope flange (Fig. 4.13).

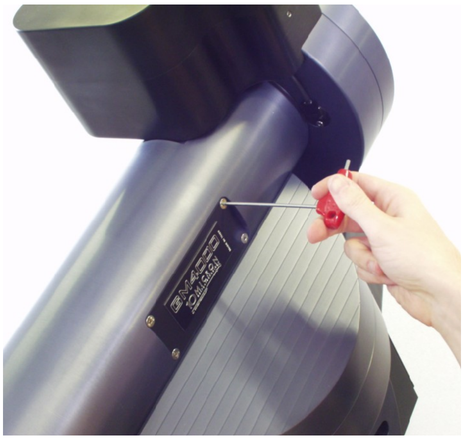


Fig. 4.10: Accessing the declination axis hole.

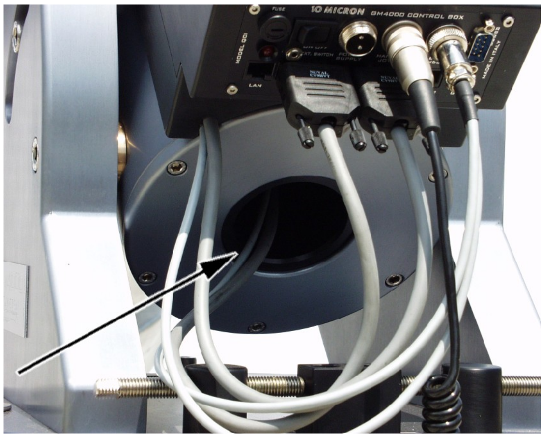


Fig. 4.11: R.A. axis hole.

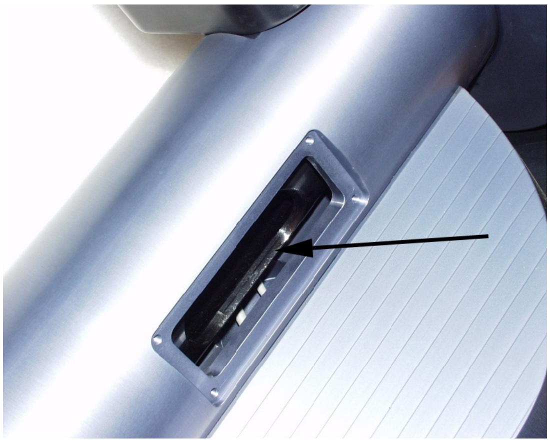


Fig. 4.12: Cable window.

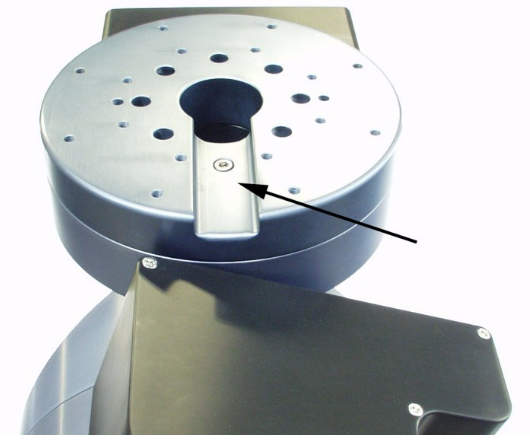


Fig. 4.13: Declination axis hole and groove.

When the mount is shipped, the cables of the declination motor and of the declination homing sensor pass already through the hole in the R.A. axis.

4.4 Mounting the Counterweights and the Telescope

Before mounting the counterweights and the telescope, ensure that the mount is in the safety position shown in Fig. 4.14, with the declination axis oriented so that the counterweight shaft points downward.

WARNING

Mounting the counterweights or the telescope when the declination axis is not in the safety position can cause sudden movement of an unbalanced load, possibly causing damage and injury.

Fig. 4.14: This is the right position to attach the counterweights and the telescope.

4.4.1 Mounting the Counterweights

Optional counterweights (Fig. 4.15) can be ordered from 10micron. Check the website www.10micron.com or ask the reseller for availability.

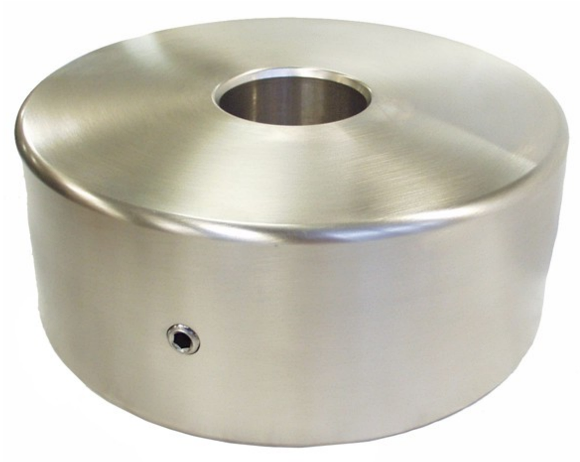


Fig. 4.15: 26kg counterweight.

Fig. 4.16: Counterweight shaft thread and mouth.

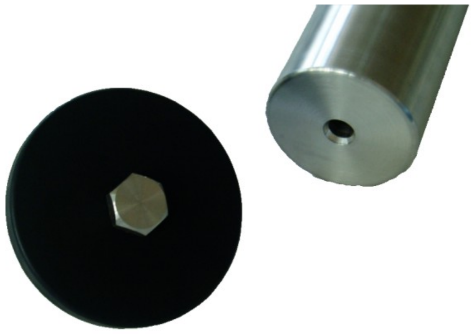


Fig. 4.17: Safety washer and screw.

Mounting the counterweight shaft is very easy. The thread have a mouth (Fig. 4.16) to allow centring. Screw the thread into the socket on the mount until it is locked in position. To insert the counterweights, remove the safety washer and screw (Fig. 4.17) from the end of the counterweight shaft. Insert an amount of counterweights at least equal to the weight of the telescope and accessories you are going to use. Lock firmly the blocking screw of each counterweight. Make sure to have counterweights in excess; this assures a good stability of the counterweights shaft when unhooking the worm gear. Remember to put back the safety washer and screw when you have finished.

WARNING

Counterweights are heavy; you must pay attention during handling to avoid injury. Never forget that they can fall on your feet and hurt you!
Damage can result to the equipment also if the declination axis is moved from the safety position with counterweights mounted but without telescope mounted on the other side.
After mounting the counterweights, proceed to mount the telescope before moving the mount.

4.4.2 Mounting the Telescope

The telescope mounting flange on the declination axis can accommodate a great variety of supporting systems.

If you utilise a dovetail plate, you can mount your telescope on a slide and then mount the slide on the dovetail plate.

For a big telescope with large and distant support rings, it is possible to make a plate to be locked directly to the declination's axis surface.

Refer to the technical drawing in Appendix C for all holes measure details.

4.5 Balancing the Telescope

Balancing the telescope is important to ensure optimal operation of the mount. If the system is not correctly balanced, pointing accuracy may suffer and the motors can lock.

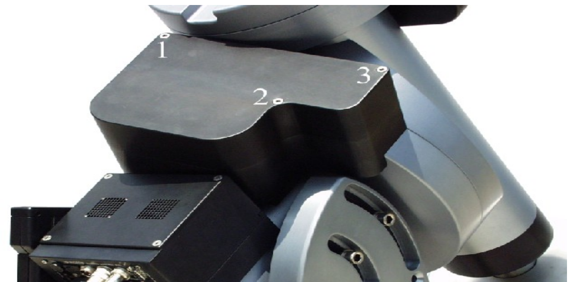
Follow the procedure closely to balance the GM4000QCI mount. Balance one axis at a time. Start with the R.A. axis and then proceed with the declination axis.

4.5.1 Balancing the R.A. Axis

Check the position of the counterweight shaft and counterweights: they must to be in the safety position of Fig. 4.14, with counterweights in excess. The safety position ensures that even if the telescope is not correctly balanced the mount is in an equilibrium position. This is important to avoid stress and damage to the gears; furthermore, if the worm gear is unhooked when the mount is not in equilibrium, the sudden movement can damage to the mount itself or cause injury.

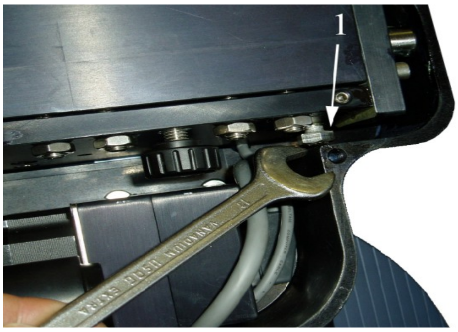
CAUTION

Consider that you have a big weight to balance! It will be a good thing to make the balancing with one person operating on the mechanics and another person to move the axes.



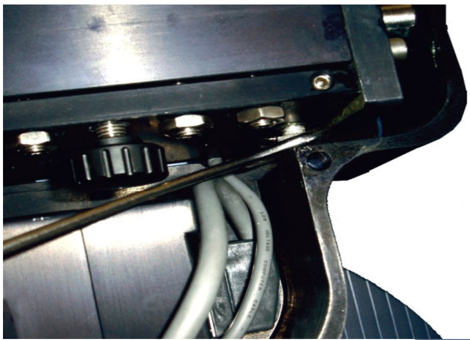
1. Remove the cover protecting the worm and the motor: loosen the three screws (1), (2), (3) holding the cover and remove them.

2. Loosen about five turns the central knob with your fingers.

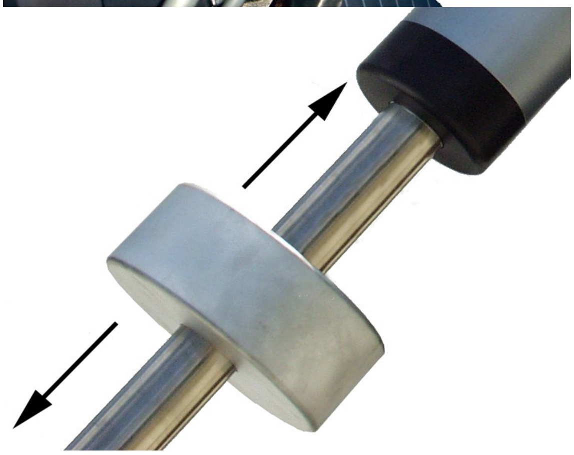


3. Take a 13mm spanner and locate the screw with the hexagonal head on the right (1).

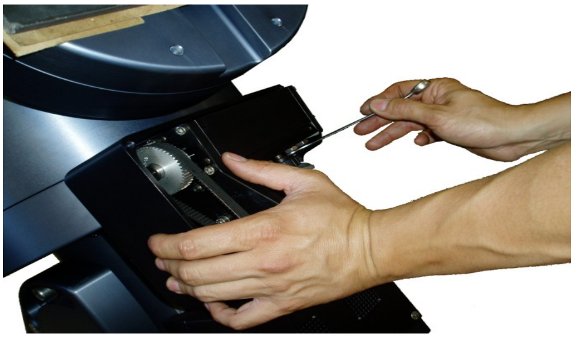
4. Push down with the hand the motor plate, keeping in balance the R.A. axis (see picture). Now the worm gear should be unhooked. Try to move by hand the R.A. axis with care continuing to push down the motor plate. Ensure that you are pressing the motor plate enough to unhook the worm gear. Now the R.A. axis should move. If this is not the case, either you have not loosened the knob of step 2 or you are not pressing enough the motor plate.



5. While continuing to push down the motor plate, turn right the hexagonal screw with the 13mm spanner until it touches the worm gear's housing. **Do not tighten the screw!** It must touch only. This operation ensure that the worm gear will be unhooked for all the time you need to balance the telescope. Now you can release the motor plate.



6. Loosen the counterweight blocking screw(s) and move with caution the counterweights along the counterweight shaft until the R.A. axis is balanced. The R.A. axis is balanced when you can move it easily with your hand and it remains in equilibrium in all positions. Remember to tighten again the blocking screw(s) when the scope is balanced.



7. When you have finished to balance the R.A. axis, push down the motor plate again and make all the operation in reverse order.
8. Loosen (turn left) the hexagonal screw with the 13mm spanner until the hexagonal head of the screw nearly touches the case. **Leave a small gap** between the head of the screw and the case. This is important to avoid propagating vibrations to the housing.
9. Release slowly the motor plate to engage the worm gear with the worm wheel moving **with care** the R.A. axis.
10. Check that the worm gear is engaged correctly.
11. Lock the central knob with your fingers.
12. Put back the motor's cover and the three screws holding it.

4.5.2 Balancing the Declination Axis

Now you must go on to balance the declination axis. The procedure is almost the same as for the R.A. axis, except for step 6, where you will have to move the telescope in its retaining rings, or use another balancing system, to balance the axis.

NOTICE

The mount can tolerate small error of balancing, but do not exceed to avoid damages.

You may balance the mount using an alternative procedure that relies on torque readout from the motors. Please refer to paragraphs 6.3.18 and 6.3.19 for details.

4.5.3 Orthogonality of the telescope

Ideally, the telescope optical axis should be orthogonal to the declination axis. A telescope is not orthogonal if the optics are pointing to an angle other than exactly 90° to the declination axis. While our mount's axes are very accurately machined and very close to being perfectly orthogonal, the telescope optical axis can be significantly misaligned. This could be due to improperly machined rings, wedge in the cradle plate, optical axis not parallel to the mechanical axis of the tube assembly.

Whatever the reason, orthogonality can be easily checked and adjusted if needed. The software of the mount can measure the orthogonality error (also called "cone error") and help you to correct it.

You can attain a good polar alignment even with a residual orthogonality error;

furthermore the orthogonality error is not a cause of drift or field rotation, so correcting it is not strictly necessary.

4.6 Fine Altitude and Azimuth Adjustment

The fine altitude and azimuth adjustment procedure must be performed with the help of the mount software in order to obtain a good polar alignment. The software provides various polar alignment routines that will assist you in this step; these are described in paragraph 5.5.

To make the fine altitude and azimuth adjustment you must locate the altitude screw (Fig. 4.18, n.1) and the azimuth screws (Fig. 4.19, n.1) on the mount.

The procedure to make the mechanical adjustments is the following:

1. Loosen the six altitude locking screws (Fig. 4.9, n.6) about a half turn.
2. Loosen about a half turn the six screws holding the mount to the pier (Fig. 4.18, n.2 and Fig. 4.19, n.2).
3. Adjust the altitude moving the R.A. body up or down with the altitude screw.
4. Adjust the azimuth moving the mount left or right using the two azimuth screws; you must back off the opposing azimuth screw in order to move the other screw in that direction.
5. When you have reached the final position, lock the six altitude locking screws and lock firmly the pier screws.

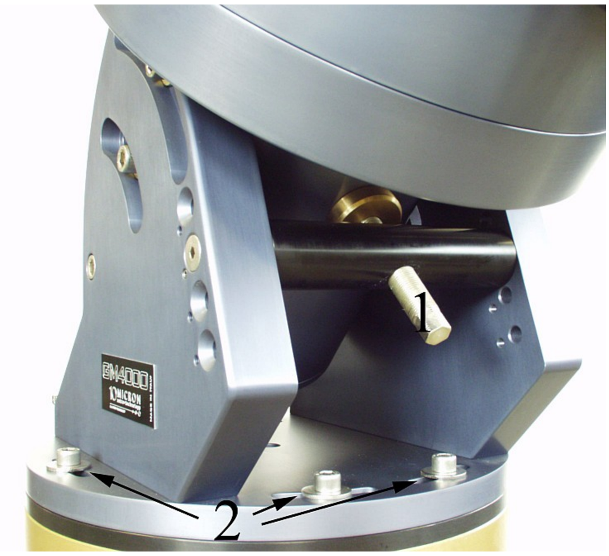


Fig. 4.18: Altitude adjusting screw.

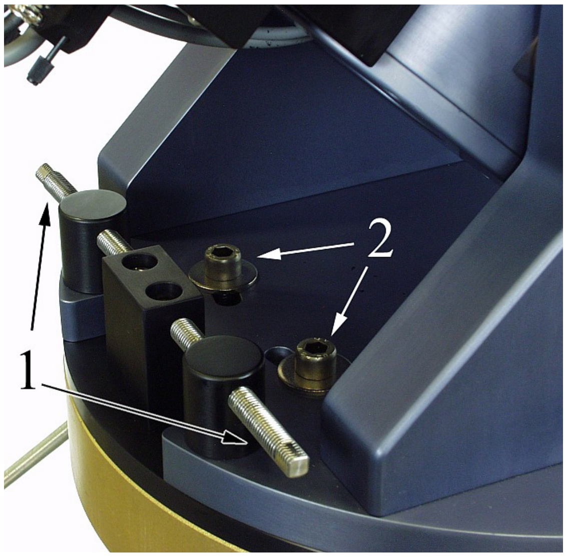


Fig. 4.19: Azimuth adjusting screws.

5 The Control Unit

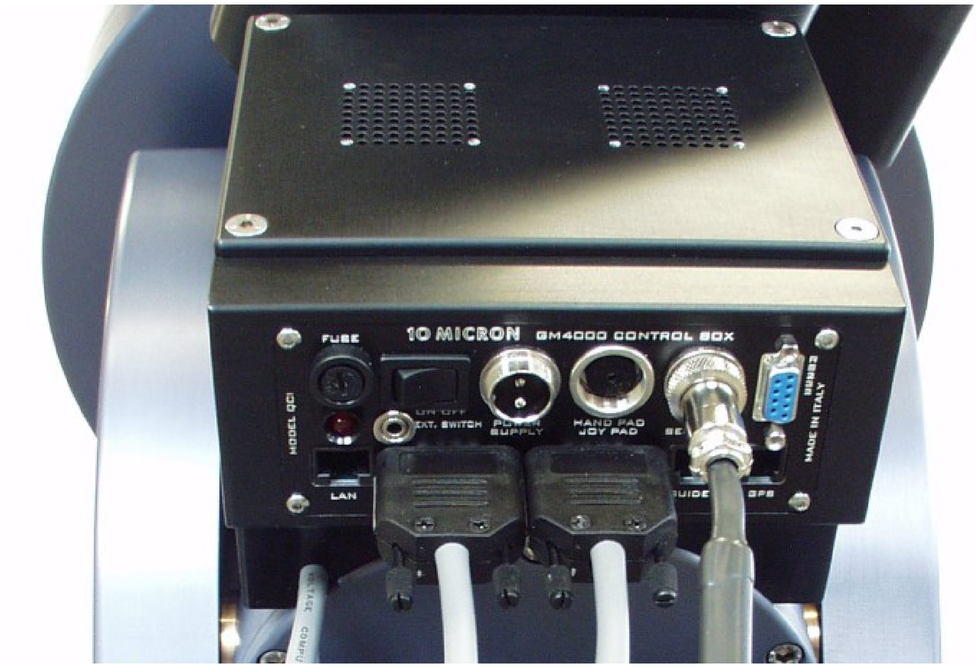


Fig. 5.1: The control box.

All electronics and electric connections are integrated in a box mounted directly on the R.A. body (Fig. 5.1). The control box is fully removable for maintenance.

The control system includes also:

- an ergonomic hand pad with 2m spiral cable and a 12-pin circular connector with security lock ring;
- a red-black cable for power supply with a 2-pin circular connector with security ring;
- two cables for connecting the motors to the control box: the declination motor cable coming out from the R.A. axis hole and the R.A. motor cable coming directly from the R.A. motor box;
- two cables connecting the homing sensors: the declination sensor cable coming out from the R.A. axis hole and the R.A. sensor cable coming directly from the R.A. motor box; the cables join in a single connector.

WARNING

All connections should be made before connecting the power supply of the mount, to avoid the risk of damaging the electronics. The LAN connection makes exception to this and can be plugged in or out while the mount is switched on.
Also don't undervalue the risk of electric shocks, even if the system is operated at 24VDC. Keep the control box clear of dew and water.

5.1 The Connection Panel

All the electronic connections are accessible from the connection panel on the

control box.

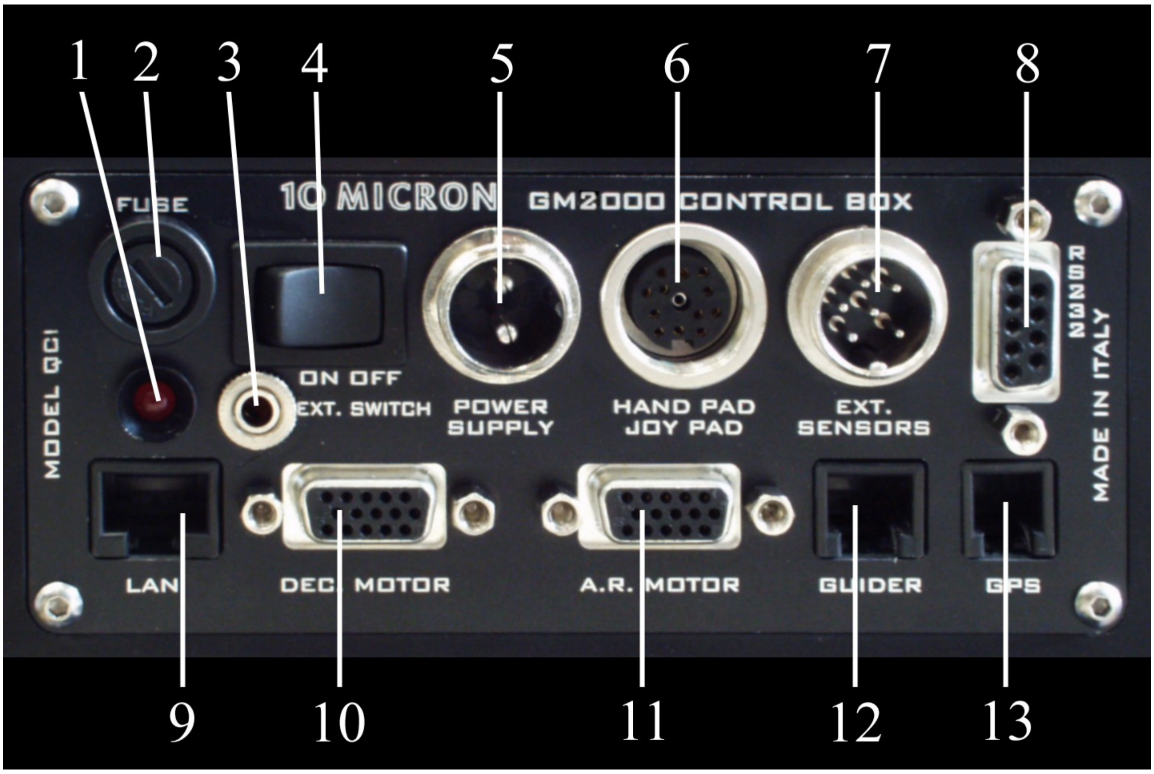


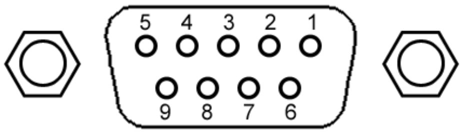
Fig. 5.2: The connection panel on the control box.

1. Power LED (red)
2. Main protection fuse (5A)
3. Connection for external on/off switching with relay box, 2.5mm stereo jack
4. Power switch
5. Power supply connector (24VDC, 6A)
6. Circular 12 pin hand pad connector
7. Circular 6 pin external homing sensor connector
8. RS-232 serial, DB-9 connector for remote PC control
9. Ethernet-LAN RJ-45 connector for remote PC control
10. R.A. motor connector
11. Dec. motor connector
12. Autoguide connector, 6-pin RJ12 (6/6)
13. Connector for GPS module (optional), or secondary RS-232 for remote PC control, 4-pin RJ11 (4/4)

5.1.1 Serial RS-232 Connector

The serial RS-232 connector (Fig. 5.2, n. 8) can be used to control remotely the GM4000QCI mount from a PC, using software such as “Guide”, “The Sky”, “Cartes du Ciel”, “Perseus” etc. Alternatively you may use this connector to control a Baader Planetarium dome directly from the mount. Please refer to paragraph 6.5.7 for details.

Use a pin-to-pin cable with one male and one female connector; only pins 2, 3 and 5 are used. Don't use a null-modem cable.



2 Transmit data (TX)
3 Receive data (RX)
5 Signal ground

Fig. 5.3: RS-232 port pinout.

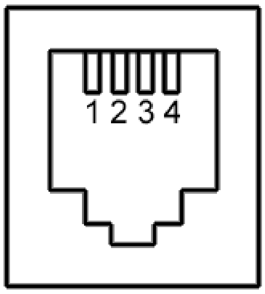
5.1.2 GPS Connector

Fig. 5.4: The optional GPS module.

The GPS socket (Fig. 5.2, n. 13) can be used with the optional GPS module (Fig. 5.4) to retrieve the coordinates of the observation site and the exact universal time.

If no GPS module is connected, the GPS socket can be used with the supplied adapter (Fig. 5.5) as an auxiliary RS-232 serial port, with the same functions as the main RS-232 serial port (including dome control).

The port is a 4-pin RJ11 (4/4) with the pinout shown in Fig. 5.6.



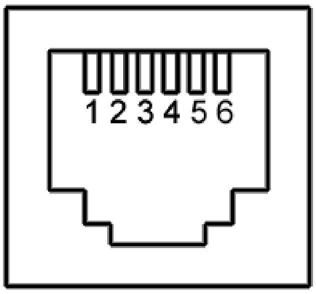
1 Receive data (RX)
2 +5V supply
3 Ground
4 Transmit data (TX)

Fig. 5.5: GPS to RS-232 adapter.

Fig. 5.6: GPS port pinout.

5.1.3 Autoguider Input

This port (Fig. 5.2, n. 12) is a RJ12 (6/6) port (sometimes also marked RJ11-6 or 6p6c) where you can connect a CCD camera or another system for automatic guiding (autoguide). The autoguide input follows the SBIG ST-4 protocol. The correction speed is by default 0.5x the sidereal speed, and can be adjusted to lower speeds (see paragraph 54). The autoguider input is always active and corrections may be operated on both axes at the same time. The corrections of the autoguide are independent of the direction keys on the hand pad; e.g. you can use the direction keys to test the autoguider system.



1	Not connected
2	Ground
3	East
4	South
5	North
6	West

Fig. 5.7: Autoguider port pinout.

The pinout is shown in Fig. 5.7. To move the mount in one of the four directions, the corresponding pin has to be put in contact with the ground pin. The magnitude of the correction is proportional to the duration of the contact.

You can also autoguide through the RS-232 serial port using the LX200 protocol.

5.1.4 Ethernet – LAN Connector

This port (Fig. 5.2, n. 9) is a 10/100Mbit LAN interface. The mount can be controlled over the network with this port in all its functions. Use a CAT.5 cable to connect to your network, like for a normal Ethernet device. See chapter 9 for details about the remote control.

5.1.5 Remote Power Switch Connector

Fig. 5.8: Remote switch jack plug and cable.

The GM4000QCI can be connected to an external relay box in order to switch on and off the system remotely, using the provided 2.5mm stereo jack connector (3-poles) of Fig. 5.2, n. 3. A suitable jack plug and cable is provided (Fig. 5.8). Only the central contacts are used. They have to be shorted by the relay box like a push-button: to switch on the mount, the contact must be closed for at least one second, and then opened. To switch off the mount correctly, you should use another pulse of the same duration. Then wait at least 30 seconds before shutting down the power supply.

The jack should be inserted with no power supply connected to the mount.

5.2 Electrical Setup

To operate the GM4000QCI mount, some electrical connections are needed. Fig. 5.9 shows the connections that are already made when the mount is shipped (i.e.,

the motors and the homing sensors). Ensure that they are correct. In addition, you need to connect the hand pad. All other connections are used for additional functionality (such as remote control and GPS). Make all connections before attaching the power supply.

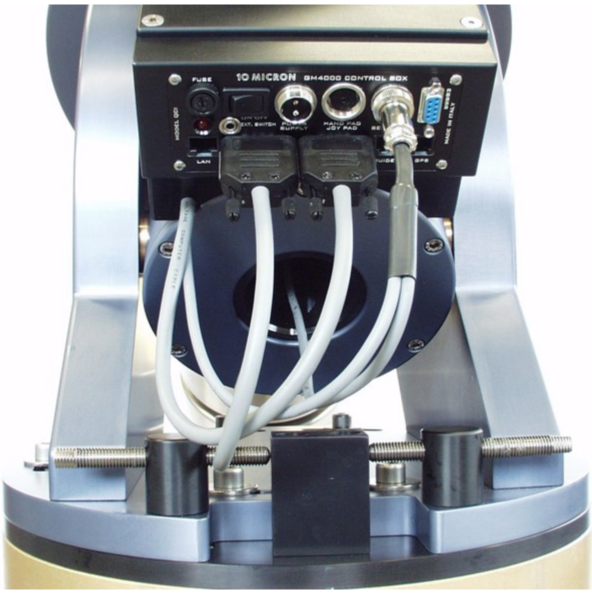


Fig. 5.9: Electrical connections setup.

5.2.1 Motors

The R.A. motor cable and the declination motor cable must be connected to the control box with two 15-pin DB male connectors.

To avoid bad connections it is important to lock the two long threaded screws of each connectors.

The two motor cables have the same 15-pin connectors; pay attention to connect the R.A. motor cable to the plug labelled "R.A. MOTOR" and the declination motor cable to the plug labelled "DEC. MOTOR". You can differentiate the cables since the R.A. motor cable comes directly from the R.A. motor box, while the declination motor cable comes out from the hole in the R.A. axis.

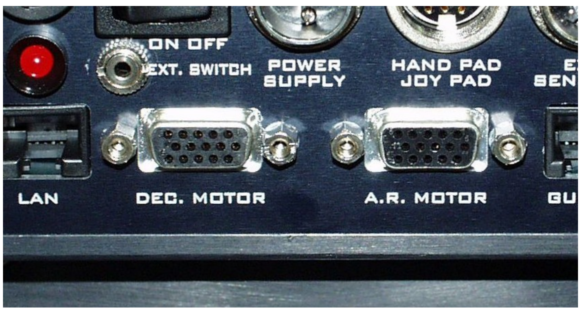


Fig. 5.10: Motor connectors.

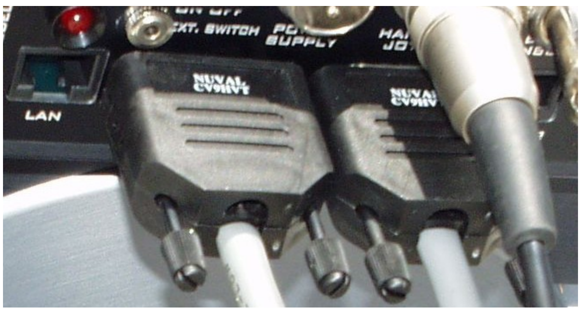


Fig. 5.11: Motor cables.

WARNING

Do not connect or disconnect the motor cables while the electronics is switched on. Otherwise the electronics and the motors may be damaged.

5.2.2 Homing Sensors

The homing sensors cables join at the connector; they should be connected to the plug labelled “EXT. SENSORS”.

5.2.3 Hand Pad

The hand pad “HAND TERMINAL QCI” must be connected to the control box with its 12 pin circular connector; to avoid bad connections it is important to lock the threaded ring of the connector.

Fig. 5.12: The hand pad.

Fig. 5.13: Hand pad cable connection.

5.2.4 Power Supply

The GM4000QCI mount requires a 24V DC, 6A regulated power supply. Use the supplied red and black cable to connect the power supply to the 2-pin round plug labelled “POWER SUPPLY” on the control box. The threaded ring of the connector should be firmly locked.

The red wire must be connected to the positive (+) pole of the power supply, the black wire must be connected to the negative (-) pole.

The protection fuse can be replaced only with another 5A slow-burning fuse. Spare fuses are available from ordinary electronic shops. If the power supply is reverse connected the protection fuse may blow, but the electronics will be safe.

The current required by the GM4000QCI system varies between 1.5A and 5A

depending on the motor speed and on the supply voltage. The operating voltage may vary from 24V to 26V. Please don't use unregulated power supplies because the output voltage of these units is not good enough to operate the mount.

When using a voltage of less than 24V the motors can stop; normal operation is not guaranteed. If you want optimal performance, you must use a 24V power supply. Suitable power supplies are available as optional.

5.3 The Hand Terminal QCI

The hand pad “HAND TERMINAL QCI” (Fig. 5.14) is a communication interface between the mount and the operator, enabling the control of all the functions of the mount. The hand pad features large control keys that can be easily found and pressed with thick gloves and a well-readable 2x16 alphanumeric LCD display that can operate in a wide range of temperature (-20 C° to +80C°), remaining readable in daylight as well as at night.

If you are using the keypad in the daylight, you may need to shade the screen from the direct sunlight with your hand in order to see it more clearly.

Brightness and contrast can be adjusted as required.

With a few keystrokes, you can slew to objects by their common name or catalogue number, set a countdown timer for a photographic exposure, set the tracking speeds, enter R.A. and Dec. coordinates to find the newest object, adjust the brightness of the display, set parameters and much more.

Fig. 5.14: The hand pad.

5.3.1 Learning to Use the Hand Pad

The first time you switch on the mount you will make some setup procedures in order to ensure correct operation. You will control the mount using the hand pad, so it is useful to make yourself comfortable with its mode of operation.

After switching on the mount, the hand pad display will show for a brief moment a screen like this:

```
10MICRON    v1.5
s/n -1
```

followed by:

```
10MICRON – Comec
booting...
```

After about a minute, when the mount electronics has completed the initialization,

the display will show the current date and time:

```
21:05:48 DST
2007 May 14
```

By pressing the ***3 = DISP*** key, the display will cycle between various data views and utility functions. They are the following:

R.A./Dec. coordinates	The equatorial coordinates where the telescope is looking
Az./Alt. coordinates	The altazimuth coordinates where the telescope is looking
H/Dec. coordinates	The hour angle and declination coordinates (both in degrees) where the telescope is looking.
Object data	The data of the current object; pressing 2-INFO will cycle between showing the name, type and magnitude of the object; its equatorial coordinates; its altazimuth coordinates.
Countdown timer	A countdown timer (see paragraph 7.1)
Chronometer	A stopwatch timer (see paragraph 7.2)
UTC clock	The current universal time
Sidereal time and JD	The current sidereal time and Julian date
Local time clock	The current local time

Pressing the ***MENU*** key, you will enter the menu system and the display will show

```
>Objects
 Alignment
```

You can scroll the menu using the keys marked with the up/down arrows and +/–. Five main submenus are available; they are **`Objects`**, **`Alignment`**, **`Drive`**, **`Local Data`** and **`Settings`**. You can enter into a submenu by pressing ***ENTER***. To exit from a submenu and return to the previous menu press ***ESC***. Pressing ***MENU*** will make you return to the main data display. For a complete reference of the menu system read the following chapters.

5.3.2 The Direction Keys

Use direction keys, labelled ***N***, ***E***, ***S***, ***W***, to move manually the telescope. Press one of these keys to accelerate the mount up to the selected speed, release it to decelerate until it stops. The ***N*** key makes the mount accelerate towards higher declinations, the ***S*** key towards lower declinations, the ***E*** and ***W*** keys towards east and west along the R.A. coordinates. In addition, you can press two keys simultaneously for diagonal movement.

The direction an object will move in the eyepiece depends also on the optical configuration of the telescope; the action of the keys can be exchanged in both axes to obtain a more comfortable control (see paragraph 6.3.4 and 6.3.5).

The speed can be selected with the keys +/– (when outside of the menu system), and the selected speed is shown in the display for some seconds. The following speeds are available:

Angular speed	Rate to sidereal speed	Notes
2.25”/sec.	0.15x	
3.75”/sec.	0.25x	
7.5”/sec.	0.5x	
15”/sec.	1x	sidereal speed
1'/sec.	4x	
4'/sec.	16x	
15'/sec.	60x	
1°/sec.	240x	
from 2°/sec. to 5°/sec.	from 480x to 1200x	slew rate, adjustable; R.A. axis up to 4°/sec. (960x)

The default speed at startup is the maximum speed (slew rate).

Note that if you are controlling the mount from a PC using the LX200 command protocol, the motion speed will be selected from the PC among the following:

Angular speed	Rate to sidereal speed	Notes
7.5”/sec.	0.5x	guide rate
6'/sec.	24x	centre rate
1°/sec.	240x	find rate
from 2°/sec. to 5°/sec.	from 480x to 1200x	slew rate, adjustable; R.A. axis up to 4°/sec. (960x)

The ***EAST*** and ***WEST*** keys can also be used to move the cursor when entering data.

5.3.3 The Numeric Keys

Beside being used to input numeric data, the numeric keys have a secondary function that is shown in small characters under the number. See the following table:

Key	Function
7 M	Select a Messier object.
8 NGC	Select a NGC object.
9 IC	Select a IC object.
4 STAR	Go to star selection menu.
5 PLANET	Go to planet selection menu.
6 MORE	Go to a menu with other selections: quick position settings, asteroids, comets, user defined objects, altazimuth coordinates, meridian flip, satellites.

Key	Function
1 COORD	Select R.A./Dec. coordinates of the object to slew to.
2 INFO	Show additional data of the current object.
3 DISP	Cycle the display between: R.A./Dec. coordinates; Az./Alt. coordinates; object data; countdown timer; chronometer; UTC clock; sidereal time and JD; local time clock.
0 LIGHT	Switch the keypad backlight on and off.

5.3.4 The MORE Key

If you press the ***MORE*** key, the mount will show a menu which contains object classes not covered by other numeric keys such as asteroids and comets. The first two items of the menu, however, can't be found under the standard **`Objects`** menu. They are dedicated to the "quick position" settings, which is a mean of quickly storing the position where the telescope is aimed to and recalling it later. This can be useful, for example, when you have to move away from your subject for some settings such as focusing and then go back to the previous position. To define a quick position, press ***MORE***, select **`Set Quick Pos`**, press ***ENTER***, and press a number corresponding to the position you want to save. You may save up to ten different positions. Later you can slew the scope to one of the defined positions: press ***MORE***, press ***ENTER***, and press the number corresponding to the position you want to slew to. Note that the positions are saved from one session to another.

5.3.5 The STOP Key

When you press the ***STOP*** key, the mount will halt its current movement. It will remain idle until a new movement command is issued (if it is not parked; see paragraph 5.6).

5.4 First Startup

This startup sequence will help you through the steps required to begin observing with the mount. You will learn to set your location and time, and perform the polar alignment. An internal clock will maintain the time, while the alignment should be repeated only when the mount is moved, or when the optical tube has lost the orthogonality with the declination axis. If none of these events has happened, you can switch off the system and at the next startup it will be ready for observation. The mount will keep track of the current position also if power is lost while operating the mount; no parking or homing is required.

CAUTION

When performing firmware upgrades, it is not guaranteed that the position of the mount will be retained in memory. Check the documentation provided with the upgrade for details.

5.4.1 Searching the Home Position and Resetting

The first time you use the mount, it will not know how it is oriented. If the mount is moved without looking for the home position, it can hit the mechanical stops. So the first thing to do is to bring the mount to the home position. Press the ***MENU*** key and scroll down to the **`Alignment`** menu. Press ***ENTER***. Scroll down until you find the **`Home Search`** function and press ***ENTER***. The display will show

```
Confirm
Home Search?
```

Press ***ENTER*** again. The display will show

```
Home search in
progress...
```

and the mount will begin to slew to the home position, swivelling back and forth at lower and lower speeds in both axes until the home position is found.

Fig. 5.15: The home position.

At the end the telescope should point as in Fig. 5.15 and the display will show for about four seconds:

```
Home search
completed.
```

Now scroll up in the menu and select the **`Reset at Home`** function. The display will show

```
Confirm
Reset at Home?
```

Press ***ENTER*** again, then press ***MENU*** to exit from the menu.

Now you can safely move the mount around without risking to hit the mechanical stops.

This procedure should be **always** made in the following cases:

– after you have setup the mount in a new place;
– after balancing the mount using the procedure described in paragraph 4.5;

- if you have disengaged the worm from the worm wheel or some other transmission gear/belt;
- after replacing one or both motors;
- after the mount has been serviced by the manufacturer;
- after a firmware upgrade that does not preserve the saved position (see the documentation provided with the firmware upgrade).

WARNING

Failing to repeat this procedure in the cases stated above can result in the mount moving in unpredictable ways, hitting the mechanical stops or causing the instrumentation to hit the base of the mount itself, possibly causing damage to the instrumentation.

5.4.2 Setting the Local Data

To find objects, the mount must know the current location, date and time. You can enter the data manually or use the optional GPS module to collect them.

If you are using the GPS module:

- make sure that the GPS module is connected and that the GPS port is set to GPS (select ***MENU*** – **`Settings`** – **`GPS port`** – **`GPS`**);
- select ***MENU*** – **`Local Data`** – **`Get GPS data`**;
- The display will show:

```
Lat  Lon  Time
Elev - 00 Sats
```

until the position and time data have been acquired. **`Sats`** shows the number of satellites that are currently tracked. The acquisition may take up to two minutes; when completed, the display will show

```
GPS data
acquired
```

If the GPS data have not been acquired in five minutes, the procedure will abort. This can happen if the GPS module is located in a position where it doesn't have a good view of the sky. In this case relocate the GPS module and repeat the procedure.

- Now select ***MENU*** - **`Local Data`** - **`Clock`** - **`Timezone`** , enter the difference between your local time and UTC (positive east), in hours and minutes, and press ***ENTER***. If you want to use UTC as your local time, enter 0.
- Now go to **`DST`** (also in the **`Local Data`** - **`Clock`** menu); press ***ENTER*** to toggle the Daylight Saving Time **`ON`** and **`OFF`**. If you want to use UTC as your local time, select **`OFF`**.

Now you can go to paragraph 5.5.

To enter data manually:

The first thing to do is entering your geographical location. You can choose a city from the location database or enter manually all data. To choose a location:

- select ***MENU*** – **`Local Data`** – **`Site`** – **`Select`**;

- choose your country with the + and – keys and press ***ENTER***;
- choose a city near you (if available) and press ***ENTER***.

To enter location data manually:

- select ***MENU*** – **Local Data** – **Site** – **Enter**;
- insert your longitude (positive west) and latitude (positive north), in degrees, minutes, and seconds. You can use the E-W direction keys to move between the different input fields; when you have finished press ***ENTER***;
- insert your elevation above sea level in meters and your time zone (difference between your local time and UTC, positive east, in hours and minutes) and press ***ENTER***.
- The mount will retain the coordinates indefinitely. You can review the current settings selecting ***MENU*** – **Local Data – Site – Current**. At this point you can also save the coordinates in the database; go to ***MENU*** – **Local Data – Site – Save** and insert a name using the ***N-E-S-W*** keys. The newly defined location will be accessed in ***MENU*** – **Local Data – Site – Select – User defined**.

Note that extreme accuracy of the observer's coordinates is not required, since they are used only to perform the correction for the refraction, to check the motion limits and to know the position of the telescope at the home position before alignment. A few arcminutes of accuracy is enough, so you can use a map to discover your latitude and longitude without any problem. As for elevation, it should be accurate to about 100 metres to compute refraction accurately.

Now you have to enter the local time. Go to ***MENU*** – **Local Data** – **Clock** – **DST**; press ENTER to toggle the Daylight Saving Time **ON** and **OFF** until the settings corresponds to your current clock. Then go to ***MENU*** – **Local Data – Clock** – **Date and Time** and enter your time and date as you can read it from an accurate clock. You can use the E-W direction keys to move between the different input fields, and the arrow keys to choose the month. When you have finished, press ***ENTER***.

NOTICE

Like all quartz clocks, the internal clock of the mount can drift slowly with time, especially if the mount is exposed to unusually low or high temperatures. Each second of error in the clock will worsen the pointing accuracy by 15 arcseconds. The clock should be kept accurately adjusted to maintain the pointing accuracy. This can be done manually, with the PC connection or with the GPS module. When adjusting the clock, it is not required to make a new alignment.

5.4.3 Setting the Refraction Parameters

The mount needs to know the temperature and pressure to compute the atmospheric refraction. By default, the mount uses a temperature of +10°C and an atmospheric pressure depending on your elevation assuming a pressure of 1013 hPa at sea level. If you need additional accuracy, go to MENU – Local Data – Refraction – Set Tempe**rature** and enter the air temperature in °C. You have three ways to enter the pressure. You can go to ***MENU*** – **Local Data** –

`Refraction` – `Set Pressure` and enter the pressure in hPa. Or you can go to ***MENU*** – `Local Data` – `Refraction` – `Set Pressure 0` and enter the pressure in hPa at sea level; the pressure at your elevation will be calculated automatically. You can also go to ***MENU*** – `Local Data` – `Refraction` – `Auto Press.` and toggle `ON` the setting; in this case the pressure will be recalculated each time the elevation is changed.

> **NOTICE**
>
> It is not advised to change any of the local data settings while tracking an object.

5.4.4 Backlash Adjustment

Since the GM4000QCI mount uses a timing belt transmission system, virtually with no backlash, usually you will leave the backlash settings to the default value of zero. Backlash adjustment is available for specially built mounts having gear reduction systems instead of the timing belt. If you experience undershooting or overshooting problems with a standard GM4000QCI mount, check the stiction compensation setting (paragraph 6.3.12). The backlash settings can be accessed from ***MENU*** – `Drive` – `Backlash`.

To set the backlash to the correct value, you can use the following procedure.

1. Set the backlash to zero arcseconds both in right ascension and declination.
2. Stop tracking selecting ***MENU*** – `Drive` – `Tracking Speed` – `Stop`.
3. Show on the display the hour angle coordinates. To do this, press ***ESC*** until you return to the main display, then press ***3 = DISP*** until the display shows `H/Dec coordinates`.
4. Point the telescope to an object on the ground; the object does not need to be very far away, provided that it can be focused; use a fairly high magnification and a reticle eyepiece; you should be able to detect an error of about one arcsecond. Alternatively, you can use a CCD camera.
5. Centre the object in the reticle.
6. Using the keypad, select a speed of 0.15x (2.25"/s).
7. Move the telescope in right ascension until you see clearly that the object has drifted away from the centre.
8. Move the telescope back until the object is exactly in the centre and note the hour angle coordinate.
9. Continue to move the telescope in the same direction until the object has drifted away on the other side.
10. Move the telescope back until the object is exactly in the centre (approaching from the other side) and note the hour angle coordinate.
11. The difference between the two coordinate readings is the right ascension backlash.
12. Repeat the steps 5–9, this time using the declination movements and coordinate to measure the declination backlash.
13. Set the backlash values in ***MENU*** – `Drive` – `Backlash`.

You can verify that the backlash settings are correct by repeating the above procedure without resetting the backlash to zero; this way the coordinate difference should be zero. Also check that, when moving at a very low speed such as 0.15x, the motion reverses immediately but without overshooting.

5.5 Alignment

Now the mount needs to be aligned to some reference stars and the polar axis aimed accurately at the celestial pole. A properly aligned mount will point routinely with a precision of about 1'.

If properly aligned, the internal mount model will keep account of the polar misalignment and of the orthogonality error when pointing objects or tracking (provided that the dual tracking function described in paragraph 6.3.3 is active), but a significant polar error can lead to a visible field rotation. While this can be acceptable for visual observing, if you plan to use the mount for astrophotography or other scientific data collection, the polar axis should be properly aligned.

It is better to do the alignment procedures using a high magnification reticle eyepiece; do not use a diagonal to centre the stars, unless it has been properly aligned in order to avoid the orthogonality error.

NOTICE

Generally, the best way to obtain a good polar alignment is to make a three-stars alignment, or a two-stars alignment followed by a refinement; then to use the **`Polar Align`** function to align the R.A. axis; then repeat the three-stars alignment (or two-stars alignment followed by the refinement). You can check the estimated polar alignment error by using the **`Align Info`** function: usually after an alignment obtained in this way the error will be no worse than about 1'. Adding further alignment stars with the **`Refine 2-stars`** function improves the accuracy.

Do not use the **`Polar Iterate`** command as your default choice for aligning the polar axis if you do not have a compelling reason to do so, since you will obtain worse results in a longer time almost in any situation.

The following paragraphs details the steps that will be used in the different alignment procedures; for the complete alignment procedures and for choosing among them depending on your situation see paragraph 5.5.9.

5.5.1 Two-stars Alignment

The two-stars alignment procedure measures the polar axis misalignment in order to achieve a good pointing accuracy even if the mount is misaligned. Proceed as follows:

1. Select ***MENU*** – **`Alignment`** – **`2-stars`**. Choose one star among the ones provided and press ***ENTER***, then choose another star and press ***ENTER***. If the choice is too limited, i.e. you cannot find a suitable pair of stars visible from your site, return to the first star selection by pressing ***ESC*** or use the three-stars alignment procedure.

2. Press ***ENTER*** to confirm the slew to the first star. After the slew, centre the star with the maximum precision using the keypad and press ***ENTER***.
3. Press ***ENTER*** to confirm the slew to the second star. After the slew, centre the star with the maximum precision using the keypad and press ***ENTER***.
4. Now the message “**`Alignment complete`**” will appear. The mount is now aligned.

Note that this procedure does not correct the orthogonality error of the telescope. If you are not sure that your telescope's optical axis is perfectly orthogonal to the declination axis, do a three-stars alignment or a refinement.

5.5.2 Three-stars Alignment

The three-stars alignment procedure measures the orthogonality error of the telescope's optical axis in addition to the polar axis misalignment, and uses it to improve the pointing accuracy. Furthermore, you can choose among more stars than using two-stars alignment, since the selection is less critical. On the other hand, you can choose stars in the same zone of sky, thus hampering the final accuracy.

1. Select *MENU* – **`Alignment`** – **`3-stars`**.
2. Choose one star from the list and press ***ENTER***.
3. Press ***ENTER*** to confirm the slew to the star. After the slew, centre the star with the maximum precision using the keypad and press ***ENTER***.
4. Repeat the steps 2. and 3. for two other stars.
5. Now the message “**`Alignment complete`**” will appear. The mount is now aligned.

Even after the three-stars alignment, you can improve the mount model by adding more stars.

5.5.3 Alignment refinement

This procedure adds more star to an existing mount model, after a two-stars or three-stars alignment.

1. Select *MENU* – **`Alignment`** – **`Refine 2-stars`**.
2. Select a star among the list.
3. Press ***ENTER*** to confirm the slew to the star. After the slew, centre the star with the maximum precision using the keypad and press ***ENTER***.
4. Now the message “Alignment refined” will appear.

You can repeat this procedure up to 25 total alignment stars.

Note that if you do a two-stars alignment followed by a refinement, the result will be the same as if you had done a three-stars alignment. Keep also in mind that one of the major inaccuracies is usually the orthogonality error; in order to correct for this error, a three-stars alignment (or a two-stars alignment followed by at least one refinement) is required.

5.5.4 Aligning the Polar Axis with the Polar Align function

This procedure uses the data computed in the alignment step to align the polar axis. If done after at least a three-stars alignment, or a two-stars alignment followed by at least one refinement, it is insensitive to orthogonality error; moreover it can be done without using Polaris, so it is very useful if you can't see

Polaris from your point of view.

The first thing to do is a two-stars alignment (paragraph 5.5.1) or a three-stars alignment (paragraph 5.5.2).

After the alignment, the mount will know the polar axis misalignment. Now do the following:

1. Select ***MENU*** – **`Alignment`** – **`Polar align`** and select a star from the list.
2. The system will ask to slew to the star. Press ***ENTER*** to confirm.
3. The scope will slew to the star and miss it. Now move the polar axis of the mount with the altitude and azimuth movements as explained in paragraph 4.6 until the star is accurately centred in the field of view and press ***ENTER***.

The polar axis now is correctly aligned, and the mount will point correctly.

However, it is advisable to make a new three-stars alignment in order to improve the pointing accuracy.

In order to obtain optimal performance, it is not required to correct physically the orthogonality error; if you wish to do so, however, the mount will help you with the procedure described in the following paragraph.

5.5.5 Iterative Alignment

This procedure uses a star (chosen among a small list) and Polaris to align the polar axis.

The accuracy of the alignment will depend of the orthogonality error of the optical axis: the larger the orthogonality error, the worse the polar axis will be aligned.

1. If you have not done it before, select ***MENU*** **`– Alignment – Home Search`** and press ***ENTER***. Wait for the homing to complete. Then select ***MENU*** **`– Alignment – Reset at Home`**. Now the system will point correctly, but with a very large error.
2. Select ***MENU*** **`– Alignment – Polar Iterate`**.
3. The system will provide a small list of suitable stars. Choose the star you prefer and press ***ENTER***.
4. Now the system will ask to slew to the star. Press ***ENTER*** to confirm the slew.
5. Centre the star with the keypad and press ***ENTER***.
6. Now the system will ask to slew to Polaris. Press ***ENTER*** to confirm the slew.
7. Centre Polaris moving the polar axis with the altitude and azimuth movements as described in paragraph 4.6 and press ***ENTER***.
8. Repeat the procedure from step 4 until both stars are centred with a good precision, i.e. you can slew between the two without significant errors.
9. Press ***ESC*** to terminate the procedure.

5.5.6 Correcting the Orthogonality Error

This procedure uses the data computed in the alignment step to correct physically the orthogonality error. It must be done after at least a three-stars alignment, or a two-stars alignment followed by at least one refinement. It is not necessary to

correct physically the orthogonality error in order to obtain a good pointing accuracy or tracking.

1. Select ***MENU*** – **`Alignment`** – **`Ortho align a`**nd select a star from the list.
2. The system will ask to slew to the star. Press ***ENTER*** to confirm.
3. The scope will slew to the star and miss it. Now adjust the orthogonality of the telescope, for example by inserting shims, until the star in centred in the field of view and press ***ENTER***.

The telescope is now orthogonal to the declination axis. It is advisable to make a new three-stars alignment in order to improve the pointing accuracy.

5.5.7 Saving the Current Alignment

If the worm wheel is disengaged or the motors replaced, the alignment will be lost and the system will not know the real position of the telescope. The alignment, then, should be repeated.

The homing function of the GM4000QCI is useful to recover the position and alignment of the mount even if a major mechanical or electronic repair has been made. The only thing required is that the on-board memory has not been replaced.

After a good alignment, select ***MENU*** – **`Alignment`** – **`Home Save`**. This will slew the mount to the home position and will save the current alignment. Now, even if you lose the alignment, you will recover it using ***MENU*** – **`Alignment`** – **`Home Search`**.

Since the GM4000QCI is able to maintain in memory the position and the current alignment of the mount in every case, even if the power is abruptly interrupted, it is *NOT* required to use the **`Home Search`** function when the mount is operated, switched on or off normally.

5.5.8 Visualisation of the Alignment Information

You can show the alignment information using ***MENU*** – **`Alignment`** – **`Align info`**. A short text will appear: scroll it with + and –. This text will tell you some useful information:

1. The type of alignment used: no complex alignment, 2-stars, 3 or more stars if you have used additional stars.
2. If 2 or more stars have been used, an estimation of the polar axis position error and its position angle relative to the celestial pole measured from the zenith towards the left, plus information about how to correct the error operating directly on the azimuth and altitude screws. An example of the display:

```
Alt 48°24'44″
Az  00°01'35″
Polar align error
00° 01' 20"
PA 232° 16'
To centre pol ax
move .04 Lf  0.2 Up
```

These values are examples of a very good alignment, requiring no further correction. The first two values show the position of the polar axis in

altazimuth coordinates: **`Alt`** is the altitude above the horizon, ideally equal to your geographical latitude without sign; **`Az`** is the azimuth measured from north towards east, ideally equal to zero in the northern hemisphere and 180° in the southern hemisphere. The third angle, marked **`Polar align error`**, is the angular deviation of the polar axis from the celestial pole; the fourth angle, marked **`PA`**, is the position angle of the polar axis with respect from the celestial pole, where 0° is the line joining the celestial pole and the zenith, and the angle is measured counterclockwise; so 0° means that the polar axis is higher than the celestial pole, 90° that it is on the left, and so on. The required adjustment is shown as ".04 Lf 0.2 Up" meaning that the mount should be moved to the left by 0.04 revolutions of the azimuth adjustment screw and up by 0.2 revolutions of the altitude adjustment screw. Usually it is better to accomplish the adjustment with the polar alignment procedure described in paragraph 5.5.4.

3. If 3 or more stars have been used, an estimation of the orthogonality error is shown as

```
Scope ortho. err
+00°12'50"
```

meaning that the angle between the telescope optical axis and the declination axis deviates from 90° by 12'50". Also in this case, it is better to accomplish the adjustment with the orthogonality correction procedure (paragraph 5.5.6).

4. The last item is a list of the stars used for alignment. This can be useful as a reference.

5.5.9 Alignment Procedures

By combining the procedures described above, you can align the mount in a number of different ways. Each way has its advantages and disadvantages.

Simple three-star alignment (not suitable for astrophotography use)
This procedure allows the mount to point correctly without aligning the polar axis. Since the tracking is done in the R.A. axis only, the polar axis misalignment will cause rather large tracking errors and field rotation, making this procedure suitable only for casual visual observation.

Procedure:

1. Do a three-stars alignment (paragraph 5.5.2).

Otherwise:

1. Do a two-stars alignment (paragraph 5.5.1).
2. Add another star with the **`Refine 2-stars`** command (paragraph 5.5.3).

Polar alignment using the mount model
This procedure will align correctly the polar axis even in presence of orthogonality error. This ensures the best pointing accuracy, accurate tracking and no field rotation. Use this procedure for astrophotography or other scientific work.

Procedure:

1. Do a three-stars alignment (paragraph 5.5.2)

2. Optionally, add one or more stars with the refine align command (paragraph 5.5.3), to be repeated at will.
3. Execute the **`Polar align`** command (paragraph 5.5.4)
4. If you want to correct the orthogonality error, execute the **`Ortho align`** command (paragraph 5.5.6). Note that even if you skip this step, the mount will point and track correctly.
5. Do again a three-stars alignment (paragraph 5.5.2)
6. Optionally, add one or more stars with the **`Refine 2-stars`** command (paragraph 5.5.3), to be repeated at will.

In the above procedure, the three-stars alignments can be replaced with two-stars alignments (paragraph 5.5.1) followed by at least one refine align command (paragraph 5.5.3).

Polar iterate alignment
With this procedure the polar axis is aligned to the celestial pole if there is no orthogonality error. An orthogonality error will worsen both the polar alignment and the pointing accuracy. This procedure requires only Polaris (or sigma Octantis in the southern hemisphere) and another star. Use this procedure only when you know that there is no orthogonality error; in this case, the resulting alignment is accurate enough for most uses.

Procedure:

1. Align the polar axis with the **`Polar Iterate`** command (paragraph 5.5.5).
2. Do a three-stars alignment (paragraph 5.5.2).
3. Optionally, add one or more stars with the **`Refine 2-stars`** command (paragraph 5.5.3), to be repeated at will.

Otherwise:

1. Align the polar axis with the **`Polar Iterate`** command (paragraph 5.5.5)
2. Do a two-stars alignment (paragraph 5.5.1).
3. Add at least one or more stars with the **`Refine 2-stars`** command (paragraph 5.5.3), to be repeated at will.

NOTICE

In the above procedures you can always choose between doing a three-stars alignment and doing a two-stars alignment followed by a refinement with an additional star. In the first case you will have a greater choice of stars, so use the three-stars alignment when you have a limited field of view. In the second case the system will restict the choice to stars placed in the best geometric conditions; this ensures a better accuracy.

NOTICE

If the polar axis is not aligned correctly, after an alignment the mount will point accurately, but tracking will be wrong, unless you activate the dual tracking option (paragraph 6.3.3). You will see the objects drifting in the field of view of the telescope, and also the equatorial coordinates on the hand pad will change while tracking. This is not an error, but it is a symptom that the mount is misaligned.

5.6 Parking the Mount

When the mount is parked, tracking is stopped and movement is not allowed. The control system, though, remains active. This allows you to "pause" the telescope during an observation session, without compromising its alignment and avoiding the need to restart the system.

The mount can be parked at the end of an observing session, to put the telescope in a predefined position i.e. to close a roof, or to have an easy access to instruments.

If the mount is switched off when parked, it will remain parked when it is switched on again, except if the "**`Alw. Unpark`**" function in ***MENU*** – **`Alignment`** – **`Boot Align`** is activated (paragraph 6.2.14). Parking before shutting down the mount will ensure that, when powered on again, it will not move until it receives the appropriate commands.

Fig. 5.16: Default park position

To park the mount, select ***MENU*** – **`Alignment`** – **`Park`** and press ***ENTER*** to confirm.

To unpark the mount, select ***MENU*** – **`Alignment`** – **`Unpark`** and press ***ENTER*** to confirm.

When the mount is parked, it will slew to a position called the "park position". By default, the park position is the one shown in Fig. 5.16, with the telescope pointing at the celestial pole. The default park position can be unpractical, because the telescope can be too high to reach. Up to three custom positions can be

defined by the user. To define a parking position, move the telescope to the desired position using the direction keys on the keypad, then select ***MENU*** – **`Alignment`** – **`Park position`** – **`Set custom pos. 1/2/3`**. When ***ENTER*** is pressed, the position of the telescope is stored in the mount memory.

To choose what to do when the mount is parked, select one of the following in ***MENU*** – **`Alignment`** – **`Park position`**:

- **`Stops only`** – when parked, the mount stops in the current position
- **`Default park`** – when parked, the mount slews to the position of Fig. 5.16.
- **`Custom park 1/2/3`** – when parked, the mount slews to the custom position 1/2/3

The selected park position is marked with a star.

5.7 Switching off the Mount

The mount can be switched off in every moment, provided that no slew is underway (in this case, an abrupt stop can happen). It is not required that the mount is parked or put in a specific position.

To shut off the mount, operate on the power switch on the control box. The red power led will remain lighted for approximately 10 to 15 seconds; only when the led is off the power supply may be switched off.

6 The Menu System

The five main menus of the GM4000QCI mount are **`Objects`**, **`Alignment`**, **`Drive`**, **`Local Data`** and **`Settings`**. The complete menu structure is detailed in chapter 13.

6.1 The Object Menu

The GM4000QCI mount contains an extensive database of celestial objects. When an object is selected, the display shows some data: the name of the object, its type (for example, **`Glob.`** for globular cluster or **`PlanNb`** for planetary nebula) and magnitude (if available). Pressing the key ***2-INFO*** will show the equatorial coordinates of the object, and pressing it again will show the altazimuth coordinates.

The system will use the following abbreviations for the object type:

`Clust.`	Open cluster
`Glob.`	Globular cluster
`Galaxy`	Galaxy
`Nebula`	Diffuse or reflection nebula
`DarkNb`	Dark nebula
`PlanNb`	Planetary nebula
`Stars`	Group of stars
`Astrsm`	Asterism
`Supern`	Supernova remnant

`Cl+Neb`	Open cluster with nebula
`Quasar`	Quasar
`Unknow`	Unknown type
`Star`	Star
`Planet`	Planet
`Satel.`	Artificial satellite
`Aster.`	Asteroid
`Comet`	Comet

The database coordinates are referred to epoch J2000.0 and are corrected for precession, nutation and light aberration; the atmospheric refraction is also considered.

If ***ENTER*** is pressed a second time (when the display shows object information), the telescope will slew to the object, provided that it is above the horizon limits as defined in paragraph 6.3.15. When the slew procedure completes correctly, the keypad will emit a beep sound.

To abort a slew for any reason, press ***STOP***.

6.1.1 Deepsky

The mount provides the following catalogues:

Menu	Designation	Objects
`Messier`	Messier	Complete, 110 objects
`NGC`	New General Catalogue	Complete, 7840 objects
`IC`	Index Catalogue	Complete, 5386 objects
`PGC`	Principal Galaxy Catalogue	Complete up to 16m, 64570 galaxies
`UGC`	Uppsala General Catalogue of galaxies	Complete, 12158 galaxies

To select an object from these catalogues, choose ***MENU*** – **`Objects`** – **`Deepsky`** – [catalogue name], enter the catalogue number and press ***ENTER***.

Some catalogues can be accessed using the shortcut keys from outside the menu: ***7-M*** for the Messier catalogue, ***8-NGC*** for the NGC catalogue, ***9-IC*** for the IC catalogue.

6.1.2 Star

The mount provides the catalogues in the following table (all are as complete as possible).

Menu	Designation	Remarks
Name	Proper name of the star	Use **+/-** and ***ENTER*** to choose from the list, in alphabetic order e.g.: Sirius
Bayer	Greek letter and constellation	Select the letter and the constellation using **+/-**, move between the two fields with the direction keys ***E*** – ***W***. e.g.: alpha CMa (=Sirius)
Flamsteed	Number and constellation	Enter the number with the numeric keys, select the constellation using **+/-**; move between the two fields with the direction keys ***E*** – ***W***. e.g.: 9 CMa (=Sirius)
BSC =HR	Bright Star Catalogue Harvard Revised	Enter the catalogue number e.g.: HR 2491 (=Sirius)
SAO	Smithsonian Astrophysical Observatory catalogue	Enter the catalogue number e.g.: SAO 151881 (=Sirius)
HIP	Hipparcos catalogue	Enter the catalogue number e.g.: HIP 32349 (=Sirius)
HD	Henry Draper catalogue	Enter the catalogue number e.g.: HD 48915 (=Sirius)
PPM	Position and Proper Motions catalogue	Enter the catalogue number e.g.: PPM 217626 (=Sirius)
ADS	Aitken's Double Star catalogue	Enter the catalogue number e.g.: ADS 5423 (=Sirius)
GCVS	General Catalogue of Variable Stars	See note

Note: the variable stars in the GCVS catalogue are identified by one or two letters and the name of the constellation, e.g. R Leo or UV Cet. The letters are assigned according to certain rules, which allow 334 identifiers in each constellation. When all these identifiers are assigned in a constellation, the star is identified with a letter V followed by a number starting from 335; thus V335 Ori is the 335th variable star found in Orion. When the GCVS catalogue is selected in the menu, you have to choose between **`letter`** and **`number`**. **`letter`** must be selected if the catalogue identifier is of the first kind (e.g.: R Leo); **`number`** must be selected

if the catalogue identifier is of the second kind (e.g.: V335 Ori).

If you have chosen **`letter`**, select the letter(s) and the constellation using the +/- keys, move between the two fields with the direction keys ***E – W***.

If you have chosen **`number`**, enter the number with the numeric keys, select the constellation using +/-; move between the two fields with the direction keys ***E – W***.

The star menu can be accessed directly from outside the menu using the key ***4-STAR***.

6.1.3 Planet

Choose the planet from the list using the +/- keys and press ***ENTER***, or press the corresponding numeric key: 0 – Sun, 1 – Mercury, 2 – Venus, 3 – Moon, 4 – Mars, 5 – Jupiter, 6 – Saturn, 7 – Uranus, 8 – Neptune, 9 – Pluto.

The planet menu can also be accessed from outside the menu using the key ***5-PLANET***.

6.1.4 Asteroid

After selection of the **`Asteroid`** menu you will have to wait a couple of seconds while the system calculates the list of asteroids. The list can be limited to objects brighter than a specified magnitude as described in paragraph 6.5.5.

The asteroid menu can be accessed from outside the menu using the key ***6-MORE***.

You can choose the desired asteroid from the list; however it is advisable to use the official asteroid number from the Minor Planet Center (e.g. "2" for Pallas). This number can be entered directly into the hand pad. You can find the official asteroid number using the web page at http://ssd.jpl.nasa.gov/sbdb.cgi.

See the documentation included with the updater program to learn how to update the asteroid table with the data you need.

6.1.5 Comet

The comet list contains several hundreds comets, beginning with 1P Halley, 2P Encke and so on. The list can be limited to objects brighter than a specified magnitude as described in paragraph 6.5.6.

The comet menu can be accessed from outside the menu using the key ***6-MORE***.

You can choose the desired comet from the list; however it is also possible to enter the number directly into the hand pad. You can find the complete designation of a comet using the web page at http://ssd.jpl.nasa.gov/sbdb.cgi.

The first entries have a number that can be entered directly into the hand pad; e.g. for "55P Tempel Tuttle" you will enter "55". With the other comets you will have to enter the year of discovery, then scroll with the keys up to the comet of interest: e.g. for "C/2001 Q4 NEAT" you will have to enter "2001" and scroll with the +/- keys.

See the documentation included with the updater program to learn how to update the comet table with the data you need.

6.1.6 Coordinates

Under this menu option you can enter the RA and Dec coordinates of the target object. This is used for objects not in the database (like a new comet).

This function can be accessed from outside the menu using the key ***1-COORD***.

To enter the coordinates use the numeric keys; you can move between the fields using the direction keys ***E*** – ***W***.

6.1.7 User Defined

Here you can define your own database. This submenu has the following functions:

`Add user obj.` - add a new object to the user database. You have to enter:

- the equatorial coordinates of the object, using the numeric keys; you can move between the fields using the direction keys ***E*** – ***W***. By default the display will show the coordinates to which the telescope is currently pointed to, so you can slew manually the telescope to the object to be inserted if you don't know its coordinates. Press ***ENTER*** to confirm.
- The object type and magnitude. Use the **+/-** keys to choose among the available types and enter the magnitude with the numeric keys; you can move between the fields using the direction keys ***E*** – ***W***. Press ***ENTER*** to confirm.
- A name for the object, using the direction keys ***N*** – ***S*** to choose each letter and the direction keys ***E*** – ***W*** to move between the letters. Press ***ENTER*** to confirm.

`Select user obj.` - slew the telescope to an object of the user database. The user database is shown in alphabetic order. Select the object to slew to by scrolling the list with the **+/-** keys and press ***ENTER***.

`Delete user obj.` - delete an object from the user database. Select the object to be deleted by scrolling the list with the **+/-** keys and press ***ENTER***. Press ***ENTER*** again to confirm the deletion.

This function can be accessed from outside the menu using the key ***6-MORE***.

6.1.8 Alt/Az Coords

Use this function to slew to a point of known altitude and azimuth. This is particularly useful for ground-based objects, like e.g. points in the landscape etc.

This function can be accessed from outside the menu using the key ***6-MORE***.

6.1.9 Meridian Flip

Usually the mount will point objects in the western part of the sky with the telescope to the east of the mount, and objects in the eastern part of the sky with the telescope to the west of the mount. It is not possible to follow an object through the meridian circle without turning around the telescope. In order to follow an object at the meridian, the GM4000QCI mount has an user-selectable tolerance that allows the telescope to go beyond the meridian by a certain amount (paragraph 6.3.13). In this way, objects lying near to the meridian can be observed with the telescope either to the east or to the west of the mount. The “meridian flip” function forces the telescope to point at the same point of the sky from the other side. This function is available only when the telescope is aiming at a point near to the meridian; if you use it in another position, an error message will be shown.

6.1.10 Satellite

Use this menu to track an artificial satellite. The artificial satellite database must

be loaded with the updater software. Since the orbits of artificial satellites can change in a few days, it is impossible to have a valid database pre-loaded in the mount.

Use the **`Satellite Find`** function to choose a generic satellite from the database. After pressing ***ENTER***, the display will show a satellite name like

```
ISS (ZARYA)
         (25544)
```

and all the others using the +/− keys.

Use the **`Next Passes`** function to choose among the satellites visible in the next minutes. You need to insert the length of the time interval you want to consider in minutes from now, then a list containing only the visible satellites will be shown.

After choosing the satellite with ***ENTER***, the display will show a list of the satellite's passes in the next 24 hours, like this:

```
07:04:39-05:38
```

meaning that the satellite will be visible from 7:04:39 until 7:05:38.

Sometimes you will find a pass shown like this:

```
17:56:39-08:27
```

meaning that the satellite will be visible from 17:56:39 until 18:08:27. Sometimes you will find two passes where the time intervals overlap, like this:

```
16:47:43-55:27
16:54:02-03:23
```

This happens when the mount cannot track the satellite in a whole run due to it going through the meridian. You can choose then if track the satellite in the arc before or after the meridian. The overlap depends on the Flip Guide Tol. setting (paragraph 6.3.14). If you choose the first of the two overlapping passes, after crossing the meridian the mount will slew automatically to catch the satellite in the remaining arc.

When you have chosen the pass you want, the mount will aim at the satellite. If the satellite is not visible yet, the mount will aim at the point where the satellite is expected to appear. Tracking of the satellite starts automatically.

While tracking the satellite, you can correct the position of the mount using the hand pad. In this case the maximum speed you can use is limited to 15'/sec.

6.2 The Alignment Menu

The alignment menu provides functions to help in the mount setup, to park and unpark the mount. They have been described in the previous chapter so here we will refer to that section.

6.2.1 Park/Unpark

`Park` is shown is the mount is operating normally, while **`Unpark`** will be show if the mount is in parked status. **`Park`** will slew to the park position and park the mount, disallowing all movements, **`Unpark`** will exit from the parked status and

allow the mount to move. See paragraph 5.6 for details about using this function.

6.2.2 Park Position

A submenu appears where you can choose what to do when parking.

- **`Stops only`** – when parked, the mount stops in the current position;
- **`Default park`** – when parked, the mount slews to the position of Fig. 5.16;
- **`Custom park 1/2/3`** – when parked, the mount slews to the custom position 1/2/3;
- **`Set custom pos. 1/2/3`** – saves the current position in memory as a custom park position.

Usage of this function is described in more detail in paragraph 5.6.

6.2.3 Polar Iterate

This function provides a method of aligning the polar axis using Polaris and a second star. See paragraph 5.5.5 for details about using this function.

6.2.4 2-Stars

This function allows you to align the mount using two stars as reference objects. See paragraph 5.5.1 for details about using this function.

6.2.5 Refine 2-Stars

This function allows you to add more stars as reference points for calibrating the mount, it must be done after the **`2-Stars`** or **`3-Stars`** alignment functions. See paragraph Errore: sorgente del riferimento non trovata for details about using this function.

6.2.6 3-Stars

This function allows you to align the mount using three stars as reference objects. See paragraph 5.5.2 for details about using this function.

6.2.7 Align Database

This function provides a sub-menu where you can save or recovery your alignment model data, without using the **`Home Search`** or **`Home Save`** functions. It has three commands:

`Load model` – load a previously saved alignment. The database is shown in alphabetic order. Select the alignment to load by scrolling the list with the +/– keys and press ***ENTER***.

`Save model` – save the current alignment in the database. Enter a name for the current model using the direction keys ***N*** – ***S*** to choose each letter and the direction keys ***E*** – ***W*** to move between the letters. Press ***ENTER*** to confirm.

`Select user obj.` - slew the telescope to an object of the user database. The user database is shown in alphabetic order. Select the object to slew to by scrolling the list with the +/– keys and press ***ENTER***.

`Delete model` - delete an alignment from the database. Select the alignment to be deleted by scrolling the list with the +/– keys and press ***ENTER***. Press ***ENTER*** again to confirm the deletion.

6.2.8 Polar Align

This function allows you to align accurately the polar axis to the celestial pole using the alignment data and without using Polaris. It must be done after the **`2-Stars`** or **`3-Stars`** alignment functions. See paragraph 5.5.4 for details about using this function.

6.2.9 Ortho Align

This function allows you to correct the orthogonality error of the telescope using the alignment data. It must be done after the **`2-Stars`** alignment function followed by a **`Refine 2-Stars`** or after the **`3-Stars`** alignment function. See paragraph 5.5.6 for details about using this function.

6.2.10 Align Info

This function shows various data about the current alignment, including the polar axis alignment error and the orthogonality error if a 2-Stars or 3-Stars alignment has been done. See paragraph 5.5.8 for details about using this function.

6.2.11 Reset at Home

`Reset at Home` tells the mount controller that the mount is in the predefined home position (the one reached with the **`Home Search`** command). All alignment data are deleted, and from now on the controller will assume an ideal mount, until more complex procedures, such as 2-stars or 3-stars alignment, are performed. See paragraph 5.4.1 for details about using this function.

6.2.12 Home Search

This function moves the mount to the home position and recovers the previously saved alignment data from the memory. It is also used to reset the mount alignment data together with **`Reset at Home`**. See paragraph 5.5.7 for details about using this function.

6.2.13 Home Save

This function moves the mount to the home position and saves the current alignment data to the memory. The alignment data can be later recovered with the **`Home Search`** function. See paragraph 5.5.7 for details about using this function.

6.2.14 Boot Align

This submenu controls the alignment operations to be performed every time the mount is switched on.

- **`Always Home`** – When this option is **`ON`**, the mount will go to the home position and recover the alignment data saved in the last Home Save operation. Press ***ENTER*** to turn this option "**`ON`**" or "**`OFF`**". This function is useful only in exceptional cases.
- **`Alw. Unpark`** - When this option is **`ON`**, the mount will begin normal operation even if it has been switched off in parked status. Press ***ENTER*** to turn this option "**`ON`**" or "**`OFF`**". This function is **`OFF`** by default.

6.3 The Drive Menu

The drive menu provides functions controlling the tracking and slewing of the mount.

6.3.1 Tracking Speed

The following options are available:

- **`Sidereal`** selects the sidereal speed, i.e. the speed used to track the "fixed" stars.
- **`Solar`** selects a speed corresponding to the average speed of the Sun. It is slightly different from the sidereal speed.
- **`Lunar`** selects a speed corresponding to the average speed of the Moon. It is rather differed from the sidereal speed, and should be used when observing the Moon. Note that this command does not keep account of the declination motion of the Moon, that can be noticeable; to have a more precise tracking, see the follow object function (paragraph 6.3.17).
- **`Custom`** allows you to specify a custom deviation from sidereal speed. It must be entered as arcseconds per minute of time of drift in RA and Dec.
- **`Stop`** shuts down tracking, but allows moving the telescope. Useful to observe terrestrial objects.

6.3.2 A-PEC control

This menu controls the periodic error correction (PEC).

The worm of the RA axis, even if it is made with the highest mechanical precision, introduces a small periodic error in the tracking motion. The period of this error corresponds to the time for a complete revolution of the worm. With the GM4000QCI this period is 3 minutes and 20.4 seconds. While for visual observation this error is completely negligible, astrophotography requires the maximum tracking accuracy to obtain excellent images, so it can be useful to have an automatic system to correct it in advance. Other components in the reduction system may introduce very small periodic errors with different periods than the worm.

The A-PECsystem must be trained. The user has to correct the tracking errors by keeping a star fixed in the field of view for the training period, using an autoguide system or even with manual corrections. The corrections are stored in memory. At the end of the training, the system computes a model that includes all the periodic errors that can be given by the mechanics and ignores all other non periodic errors. The errors are stored so that they can be corrected automatically while the A-PEC system is active. Note that the training takes more than one revolutions of the worm. This enables the system to fit and correct also the very small errors of the belt reduction system.

The following options are available:

- **`No A-PEC`** – the correction of the periodic error is switched off.
- **`A-PEC Active`** – the correction of the periodic error is switched on. By default the periodic error data is blank, so this option will have no effect until you have trained the system with the PEC training function.
- **`A-PEC Training`** – this function is used to make the GM4000QCI "learn" the corrections to make. Choose a star near the equator (to increase the

sensitivity of the RA corrections) and the meridian (to minimise the effect of atmospheric refraction). Observe the star with a high magnification reticle eyepiece. The star will appear to "wobble" very slowly in RA as a result of the periodic error. This movement can be corrected with the E – W direction keys of the hand pad or (better) with an autoguide system. While guiding on the star as described, use this option to start the learning process of the mount. You will have to choose if you want to train the system for a period of 15, 30 or 60 minutes. The longer the training period, the more accurate the error measurement will be. The recording of the corrections begins after about 10 seconds. You must continue guiding on the star until the training is completed. When the procedure is terminated you will hear a "beep" and the tracking mode will switch automatically to "**`A-PEC Active`**". The training procedure is interrupted if you move the mount at more than 15"/s, if you begin a slew, or if the error is too big to compensate for.

6.3.3 Dual tracking

Press ***ENTER*** to activate ("**`*`**") or deactivate this function. When this function is active, the tracking will be done on both axes in order to compensate the drift due to alignment errors and atmospheric refraction. The best results can be obtained only if the system has been accurately aligned with multiple stars. We recommend that you activate this function as your default. Use this in conjunction with the **`A-PEC`** function to enable the maximum tracking accuracy: when both functions are enabled, the control software will correct all inaccuracies resulting from its pointing model and periodic (mechanical) errors.

6.3.4 Swap E – W

When pressing the direction keys, the direction an object will move in the eyepiece depends on the optical configuration of the telescope. This function can swap the effect of the ***E*** and ***W*** keys on the hand pad to obtain a more comfortable control. Press enter to activate ("**`ON`**") or deactivate ("**`OFF`**") this function.

6.3.5 Swap N – S

When pressing the direction keys, the direction an object will move in the eyepiece depends on the optical configuration of the telescope. This function can swap the effect of the ***N*** and ***S*** keys on the hand pad to obtain a more comfortable control. Press enter to activate ("**`ON`**") or deactivate ("**`OFF`**") this function.

6.3.6 Auto Swap N – S

The action of the ***N*** and ***S*** keys is reversed with respect to the true North and South directions when the telescope changes from east to west of the meridian. This function can swap the effect of the ***N*** and ***S*** keys on the hand pad depending on the side of the meridian you are looking at. Press enter to activate ("**`ON`**") or deactivate ("**`OFF`**") this function.

6.3.7 Corr. Speed

When moving the telescope in right ascension at high declination, the angular rate on the right ascension will be reduced by a factor $\cos\delta$, where δ is the declination. If this function is activated, the angular rate of the right ascension axis will be modified by multiplying it by $\cos\delta^{-1}$, thereby obtaining a constant angular rate on the sky .Press enter to activate ("**`ON`**") or deactivate ("**`OFF`**") this function. This

function has effect also on the autoguide speed. By activating this function you can effectively avoid to realign your autoguide when if you observe at different declinations.

6.3.8 Slew Rate

Set the maximum speed in degrees/second, from 02°/s to 05°/s.

6.3.9 Autoguide speed

Here you can choose the autoguide correction speed among the values 1.00x, 0.50x, 0.33x, 0.25x, 0.20x, 0.15x and 0.10x the sidereal speed. This setting affects only corrections made using the autoguider interface (described in paragraph 25).

6.3.10 Tracking corr.

The tracking speed can be corrected up to +/-9.999%. A correction of 0.11% corresponds to a drift of 1 arcseconds per minute of time.

6.3.11 Backlash

Here you can change the backlash settings. A suitable procedure is described in paragraph 5.4.4.

6.3.12 Stiction comp.

The word "stiction" refers to the phenomenon of static friction. When you try to start moving an axis at rest (i.e. the declination axis), the gears stick together until the force is big enough to overcome the static friction, then the motion starts abruptly. The pratical effect of stiction is that if you apply numerous small correections to the declination axis, the first ones will have no effect, then at a certain point you will obtain an overcorrection. This can be a problem during autoguiding. The default value of **15** is a good starting point. If you see that in order to obtain an autoguide correction you need to apply many corrections from your autoguiding software, i.e. that the mount appears to ignore the corrections for a long time, increase this value. If the autoguide corrections have a tendency to "overshooting", decrease this value.

6.3.13 Flip Slew Tol.

Normally, the mount will point an object going to the “correct” side of the meridian; i.e. the telescope will be to the east of the mount when observing an object in the western sky and vice versa. This option allows you to “anticipate” an object that has not yet crossed the meridian, if the object is nearer than the specified value to the meridian. The user movements are blocked after they have gone through the meridian the “wrong way” more than this value. The value can vary from 1 to 15 degrees. Since this feature allows the telescope to go to the “wrong” side of the meridian, check that the value you enter here does not allow collisions between the instrumentation and the mount or the mount's support.

6.3.14 Flip Guide Tol.

This option allows you to track an object through the meridian for up to 15 degrees on the “wrong” side. The value can vary from 2 to 15 degrees, and must be greater than the **`Flip Slew Tol.`** value. Since this feature allows the telescope to go to the “wrong” side of the meridian, check that the value you enter here does not allow collisions between the instrumentation and the mount or the

mount's support.

6.3.15 Horizon Limit

This is the minimum altitude angle the telescope will slew to. It is –1° by default and can be adjusted in the range –5° to +90°.

6.3.16 Track warn.

If this option is active, the mount will show a warning message and emit a sound whenever the tracking time left for an object crossing the meridian goes below 30, 10, 5, 2 and 1 minutes. The warning sound is composed of a long beep followed by two fast beeps that repeat every six seconds for a minute. In the last minute of tracking, and in the first minute after the tracking stops, you will hear a long beep every six seconds.

6.3.17 Follow Obj.

When this function is active, everytime you slew to a celestial object from the database, the apparent proper motion of the object is computed, and is set automatically as a "custom tracking rate" (paragraph 6.3.1). This is effective for all solar system objects, such as asteroids, comets, planets, the Sun and the Moon. Press ***ENTER*** to turn this option "**`ON`**" or "**`OFF`**".

6.3.18 Balance RA

This function is provided to help you in balancing the right ascension axis. Before using this function, make sure that you have execute the "Reset at home" command or that you have a good alignment (i.e. the telescope points stars more or less correctly). Then select the function and press ENTER. The telescope will slew in sequence to two balance positions, shown in Fig. 6.1 (A and B) and will make an up and down movement at each position. At the end of the procedure the display will show a percentage. If the percentage is in the range –0.20% – +0.20%, the telescope is correctly balanced. If the percentage is greater than 0.20%, move counterweights towards the mount; if the percentage is less than –0.20%, move counterweights towards the end of the bar.

6.3.19 Balance Dec

This function is provided to help you in balancing the declination. Before using this function, make sure that you have execute the "Reset at home" command or that you have a good alignment (i.e. the telescope points stars more or less correctly). Then select the function and press ENTER. The telescope will slew in sequence to two balance positions, shown in Fig. 6.1 (C and D) and will make an up and down movement at each position. At the end of the procedure the display will show a percentage. If the percentage is in the range –0.20% – +0.20%, the telescope is correctly balanced. If the percentage is greater than 0.20%, the telescope is front-heavy; if the percentage is less than –0.20%, the telescope is back-heavy.

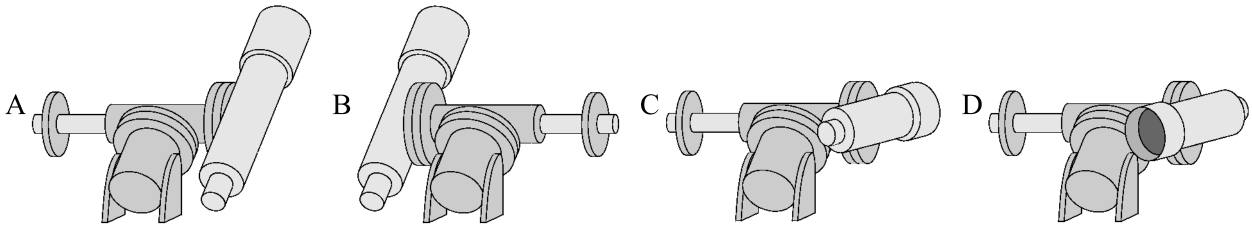


Fig. 6.1: Balance positions. A and B, positions for balancing the right ascension axis. C and D, positions for balancing the declination axis.

6.4 Local Data

The local data menu is used to enter the data relative to your observing site (location, time, etc.).

6.4.1 Clock

Under this submenu you find the functions to set the clock of the mount.

- **`Date and time`** – Select this function to input the date and time. See paragraph for details about using this function.
- **`Local Timezone`** – Select this function to input the local time zone. See paragraph for details about using this function.
- **`DST (Daylight Saving Time)`** – Turn this option "**`ON`**" or "**`OFF`**" to activate or deactivate the daylight saving time correction. Select this function to input the date and time. See paragraph for details about using this function.

6.4.2 Site

This submenu has the following functions:

- **`Current`** – Show the current site information (name, coordinates, elevation and time zone). The text can be scrolled with the +/– keys. Press ***ESC*** to leave the information display.
- **`Select`** – Select the observing site from a database of cities. See paragraph for details about using this function.
- **`Enter`** – Enter the coordinates of the observing site. See paragraph for details about using this function.
- **`Save`** – Save the current observing site to the user database. See paragraph for details about using this function.
- **`Delete`** – Delete an observing site from the user database. Select the site among the list and press ***ENTER***, the press ***ENTER*** again to confirm deletion.

6.4.3 Get GPS Data

If the optional GPS module is connected to the control box, this function gets the exact coordinates of the observing site and the universal time (UTC). The time zone and the daylight saving time should be inserted manually if necessary (they are not necessary for locating objects correctly, but only to display the correct local time).

If the GPS module is already connected at boot and the corresponding boot option is active, the GPS data have already been collected during the boot process. Otherwise, the GPS module can be connected later and the data can be collected

with this function. If the data have been acquired correctly, the display will show

```
GPS correctly
acquired.
```

This function cannot operate if the second serial port is not set to GPS (see paragraph 6.5.2).

6.4.4 Boot GPS Sync

When this option is ON, a GPS module is searched at boot to get the date, time and geographical coordinates. Press ENTER to turn this option “ON” or “OFF”. This function cannot operate if the second serial port is not set to GPS (see paragraph 6.5.2).

6.4.5 Refraction

This submenu is used to input data for computing the refraction. It has the following functions:

- **`Show Current`** – Show the current refraction data. The text can be scrolled with the +/– keys. Press ***ESC*** to leave the information display.
- **`Set Temperature`** – Enter the air temperature at the observing site.
- **`Set Pressure`** – Enter the atmospheric pressure at the observing site in hPa.
- **`Set Pressure 0`** – Enter the atmospheric pressure at sea level in hPa, if the pressure at the observing site is not available.
- **`Auto Press.`** – If this function is selected, the pressure will be computed automatically from the elevation data in the **`Local data`** – **`Site`** menu (see paragraph).

The setting of the refraction data is explained in paragraph 5.4.3.

6.5 Settings

The settings menu is used to setup the mount and customise its operation. Some of the functions of this menu have already been described in previous sections, so here we will refer to that sections if necessary.

6.5.1 User Interface

In this submenu you can set various functions related to the user interface of the keypad.

- **`Brightness`** – The brightness of the display can be adjusted at the following levels: Maximum – High – Medium – Low – Minimum. The current level is marked with a star.
- **`Contrast`** – The contrast of the display can be adjusted at the following levels: Maximum – High – Medium – Low – Minimum. The current level is marked with a star. Usually “Maximum” is the correct value, except when the ambient temperature is high.
- **`Beep`** – When this option is **`OFF`**, the “beep” sound of the keypad is never emitted. Press ***ENTER*** to turn this option “**`ON`**” or “**`OFF`**”.
- **`Boot Display`** – This controls what the display should show by default

after switching on. Choose among:

RA/Dec Coord.	Show the equatorial coordinates
Alt/Az Coord.	Show the altazimuth coordinates
Lcl time clock	Show the current local time
UTC clock	Show the UTC time
Chrono	Show the stop clock (paragraph 7.2)
Timer	Show the timer (paragraph 7.1)

The date and time are always displayed at first after boot, this settings becomes effective after the pressure of e.g. the direction keys. The key ***3-DISP*** can be used to switch between the display of the various information above, and additionally the Sidereal Time and Julian Date.

6.5.2 GPS Port

This menu selects the functionality of the GPS port.

Choose:

- **`GPS`** – to allow searching for a GPS module connected to the GPS port.
- **`Serial`** – to use the GPS port as an auxiliary RS232 port for remote control.
- **`Dome`** – to control a Baader Planetarium motorized dome connected directly to the GPS port.

6.5.3 Emulation

This menu concerns the emulation mode of the RS-232 communication. The GM4000QCI mount can emulate the LX200 protocol or the (very similar) Astrophysics GTO protocol. Choose:

- **`Emul. LX200`** to emulate the LX200 protocol
- **`Emul. AP`** to emulate the Astrophysics protocol

The active protocol is marked with a star.

6.5.4 Network

The GM4000QCI can be operated by remote control over a 10/100Mbit/s Ethernet LAN with the TCP/IP protocol. See chapter 9 for details.

- **`Show IP address`** – The current network parameters are shown. Scroll the text with the +/- keys, press ***ESC*** to leave the information display.
- **`Config Network`** – The network configuration can be set to one of the following:
  - **`Use DHCP`** – When this option is selected, the mount will ask a DHCP server on the network to provide an IP address.
  - **`Set IP address`** – When this option is selected, the parameters can be entered manually; this is useful if your network does not have a DHCP server or if you are connecting the mount directly to a PC with a “crossed” cable. The following parameters should be entered:
  - IP address: e.g. 192.168.001.099 (different from the IP address of the PC but on the same subnet)

- Network mask: e.g. 255.255.255.000
- Gateway: e.g. 192.168.001.001

(the actual data may differ from these depending on the configuration of your network)

6.5.5 Asteroid Filter

The list of asteroids can be limited to objects brighter than the specified magnitude. Press ***ENTER*** to enter the menu; the following functions are available:

- **`Filter`** – Control whether the filter is active or not. Press ***ENTER*** to turn this option "**`ON`**" or "**`OFF`**".
- **`Limit magnitude`** – Pressing ***ENTER*** will show the current magnitude limit; enter a new magnitude limit with the numeric keys and press ***ENTER***.

6.5.6 Comet Filter

The list of comets can be limited to objects brighter than the specified magnitude. Press ***ENTER*** to enter the menu; the following functions are available:

- **`Filter`** – Control whether the filter is active or not. Press ***ENTER*** to turn this option "**`ON`**" or "**`OFF`**".
- **`Limit magnitude`** – Pressing ***ENTER*** will show the current magnitude limit; enter a new magnitude limit with the numeric keys and press ***ENTER***.

6.5.7 Dome

This menu contains the settings for controlling a Baader Planetarium motorized dome, connected to the mount using the RS-232 or the GPS port with serial adapter. Press ***ENTER*** to enter the menu; the following functions are available:

- **`Open Shutter`** – opens the dome.
- **`Close Shutter`** – closes the dome.
- **`Home`** – forces the dome to do a 360 degrees rotation, to force the detection of the homing sensor.
- **`Dome Control`** – here you can choose between "**`No dome`**", "**`Dome on GPS`**" or "**`Dome on RS232`**" to set the port where the dome is connected. The mount will send the azimuth to the dome at fixed intervals. Select "**`Update interval`**" to change the interval; the default is 5 seconds. Use "**`Dome radius`**" to specify the dome radius (not diameter) in mm.
- **`Mount Type`** – specify if your GM4000's supporting shoulders stick out from the pillar from the front side (i.e. towards the declination axis) or from the back side. This is required to compute the position of the telescope.
- **`Mount position –`** specify the mount position with respect to the dome. **`Xm`**, **`Ym`** and **`Zm`** are the offsets of the mount towards North, East and the Zenith, respectively, measured in mm from the centre of the spherical part of the dome to the centre of the base of the mount (see Fig. 6.2).
- **`Scope offset –`** specify the position of the optical axis of the telescope relative to the declination mounting flange (see Fig. 6.3). X is the lateral displacement, measured from the centre of the mounting flange, positive towards right if looking from the back of the optical tube (usually X is zero).

Y is the distance from the flange to the optical axis (usually it is the radius of the optical tube). All measures are in mm.

NOTICE

If the parameters for the dome control are not specified correctly, the dome will behave erratically or not move at all. Check that all the data are correct before suspecting communication problems.

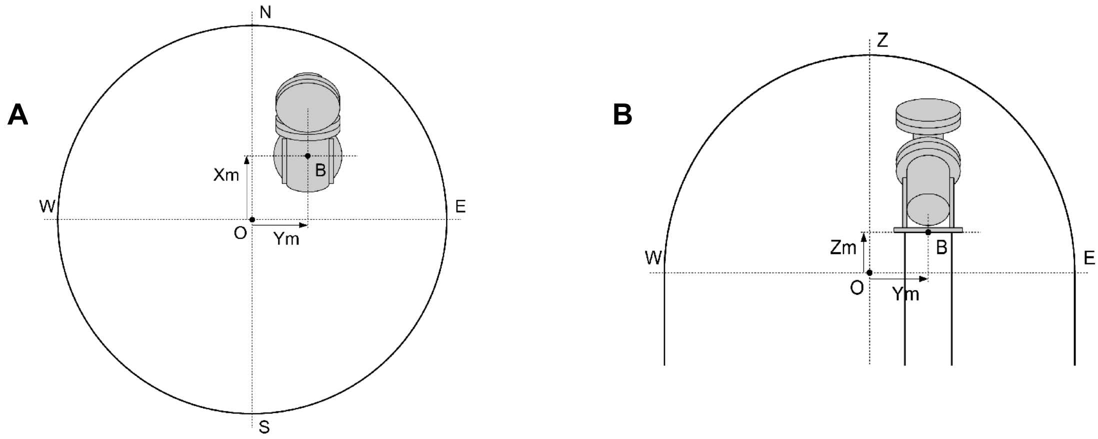


Fig. 6.2: Position of the mount inside the dome. Note that measurements are taken from the centre of the spherical part of the dome to the centre of the base of the mount. Usually Zm will be negative.

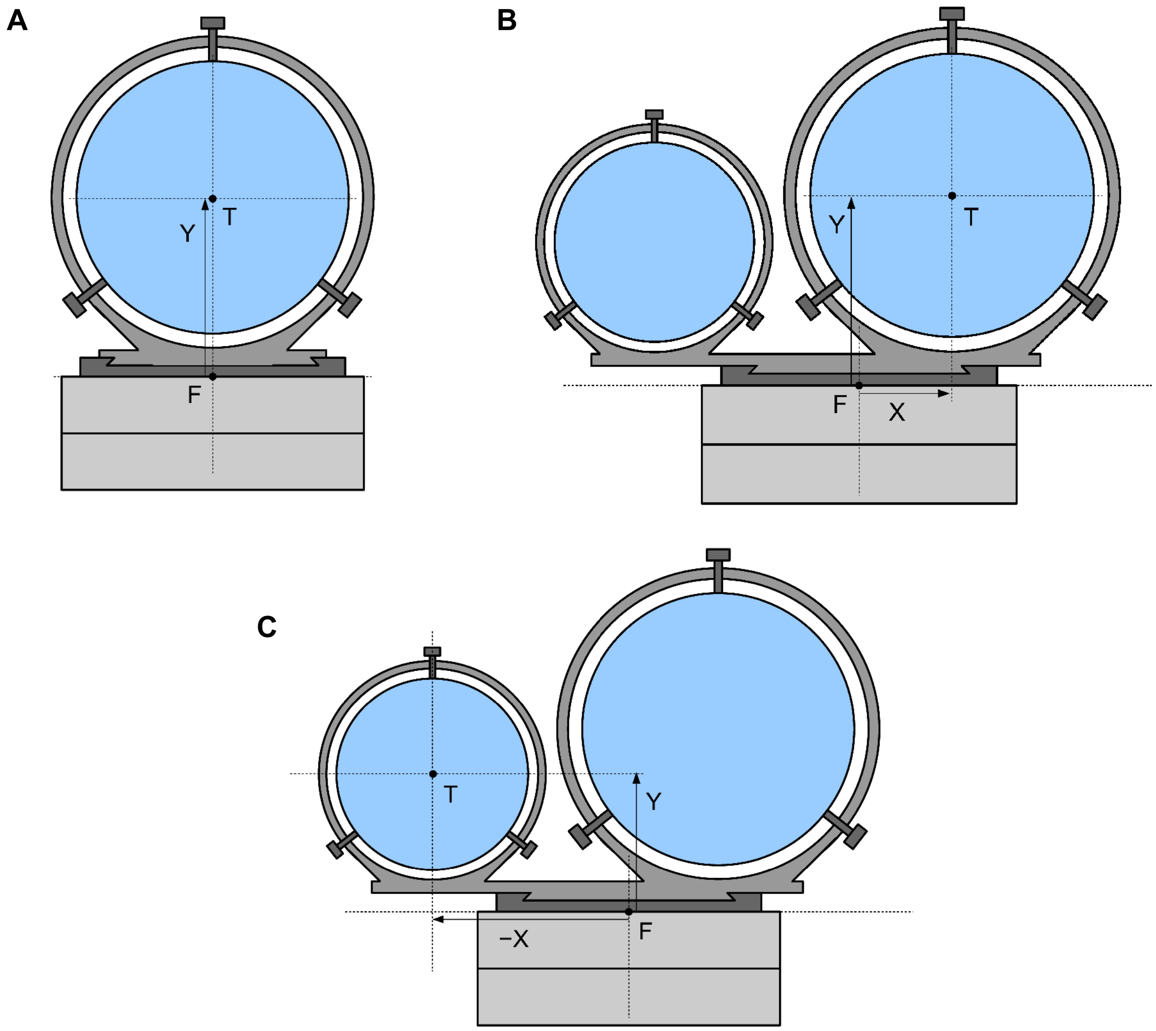


Fig. 6.3: Position of the optical tube assembly with respect to the declination flange, seen from the back of the optical tube. In **A** the usual case where the optical tube assembly is centered with respect to the declination axis; in this case X is zero. In **B** and **C**, a configuration with two optical tubes. To centre the dome shutter above one of the two instruments, specify X and Y as in the drawings. In **C**, X is negative, since the optical axis is to the left of the declination axis.

6.5.8 Version

This function shows a text containing the firmware revision and date, and the version of the RA and Dec motors' firmware. Scroll the text with the +/- keys, press ***ESC*** to leave the information display.

6.5.9 Language

This function allows you to choose the language for the interface of the hand terminal QCI. The languages supported depend on the version of the hand controller attached to the mount.

7 Additional Functions

These utility functions are provided outside the menu, and can be accessed by pressing the key ***3-DISP***.

7.1 Countdown Timer

This timer function is useful e.g. for astrophotography. Press the key ***3-DISP*** several times, until "**`Countdown timer`**" is shown on the display. A two-line display will appear:

```
00:00:00.0 Left
00:00:00.0 Tot
```

The numbers stands for hours, minutes, seconds and tenths of second.

Press ***ENTER*** to set the desired time interval. The display will change to

```
Set timer
 00:00:00.0 Tot
```

where you can change the time using the numeric keys and the ***E*** – ***W*** direction keys to move between the fields. Press ***ENTER*** to start the countdown. The timer begins to run and when the count reaches zero several beeps will warn you that the timer is expired.

Press ***ENTER*** while the timer is running to stop the countdown.

7.2 Stop Watch

This stopwatch function is useful for measuring time intervals. Press the key ***3-DISP*** several times, until "**`Chronometer`**" is shown on the display. A single-line display will appear:

```
00:00:00.0
```

The numbers stands for hours, minutes, seconds and tenths of second. Press ***ENTER*** to start measuring the time interval. The timer begins to run and will continue until you press ***ENTER*** again to stop it. To zero the timer, press ***ENTER*** a third time.

8 Alignment Stars

This chapter provides a list of the stars used for the alignment of the mount. The mount knows the position of the alignment stars with extra accuracy, and corrects also their proper motions. Charts for locating the alignment stars in the sky are provided.

8.1 List of Reference Stars Sorted by Constellation

Constellation Latin name	Constellation English name	Stars
Andromeda	Andromeda	Mirach – Alpheratz
Aquarius	Water Carrier	Beta Aqr – Lambda Aqr
Aquila	Eagle	Altair
Aries	Ram	Hamal
Auriga	Charioteer	Capella
Boote	Herdsman	Arcturus
Camelopardalis	Giraffe	Alpha Cam
Canes Venatici	Hunting Dogs	Cor Caroli
Canis Major	Greater Dog	Sirius
Canis Minor	Lesser Dog	Procyon
Capricornus	Goat	Omega Cap
Cassiopeia	Cassiopeia	Caph – Gamma Cas
Centaurus	Centaur	Menkent
Cepheus	Cepheus	Alderamin
Cetus	Whale	Diphda – Menkar
Corona Borealis	Northern Crown	Gemma
Corvus	Crow	Gienah Ghurab
Cygnus	Swan	Albireo – Deneb
Draco	Dragon	Eltanin
Eridanus	River	Zaurak
Fornax	Furnace	Alpha Fornacis
Gemini	Twins	Castor – Pollux
Hercules	Hercules	Zeta Herculis – Pi Herculis
Hydra	Water Serpent	Alphard
Leo	Lion	Denebola – Regulus
Libra	Balance	Zuben el Genubi
Lynx	Lynx	Alpha Lyncis
Lyra	Lyre	Vega
Ophiucus	Serpent Bearer	Ras Alhague – Nu Ophiuchi
Orion	Orion	Betelgeuse – Rigel
Pegasus	Pegasus	Algenib – Enif – Scheat
Perseus	Perseus	Mirfak – Zeta Persei
Puppis	Stern	Rho Puppis
Scorpius	Scorpion	Antares
Serpens	Serpent	Unukalhai
Taurus	Bull	Aldebaran
Ursa Major	Great Bear	Alkaid – Dubhe – Muscida – Alula Borealis
Ursa Minor	Little Bear	Kochab – Polaris
Virgo	Virgin	Spica – Vindemiatrix

8.2 List of Reference Stars Sorted by Name

Star	Constellation Latin name	Constellation English name
Albireo	Cygnus	Swan
Aldebaran	Taurus	Bull
Alderamin	Cepheus	Cepheus
Algenib	Pegasus	Pegasus
Alkaid	Ursa Major	Great Bear
Alpha Cam	Camelopardalis	Giraffe
Alpha Fornacis	Fornax	Furnace
Alpha Lyncis	Lynx	Lynx
Alphard	Hydra	Water Serpent
Alpheratz	Andromeda	Andromeda
Altair	Aquila	Eagle
Alula Borealis	Ursa Major	Great Bear
Antares	Scorpius	Scorpion
Arcturus	Boote	Herdsman
Beta Aqr	Aquarius	Water Carrier
Betelgeuse	Orion	Orion
Capella	Auriga	Charioteer
Caph	Cassiopeia	Cassiopeia
Castor	Gemini	Twins
Cor Caroli	Canes Venatici	Hunting Dogs
Deneb	Cygnus	Swan
Denebola	Leo	Lion
Diphda	Cetus	Whale
Dubhe	Ursa Major	Great Bear
Eltanin	Draco	Dragon
Enif	Pegasus	Pegasus
Gamma Cas	Cassiopeia	Cassiopeia
Gemma	Corona Borealis	Northern Crown
Gienah Ghurab	Corvus	Crow

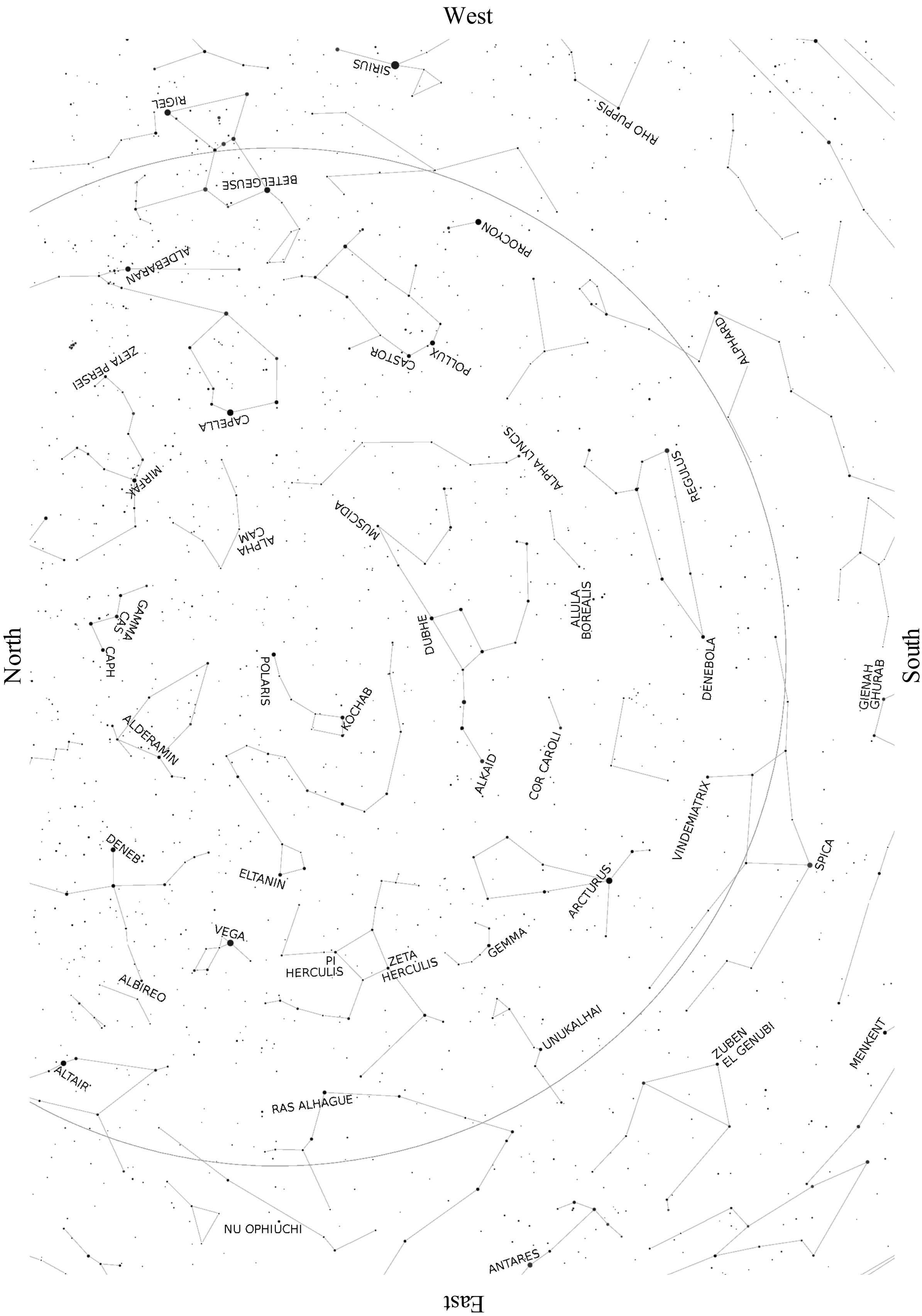
Star	Constellation Latin name	Constellation English name
Hamal	Aries	Ram
Kochab	Ursa Minor	Little Bear
Lambda Aqr	Aquarius	Water Carrier
Menkar	Cetus	Whale
Menkent	Centaurus	Centaur
Mirach	Andromeda	Andromeda
Mirfak	Perseus	Perseus
Muscida	Ursa Major	Great Bear
Nu Ophiuchi	Ophiucus	Serpent Bearer
Omega Cap	Capricornus	Goat
Pi Herculis	Hercules	Hercules
Polaris	Ursa Minor	Little Bear
Pollux	Gemini	Twins
Procyon	Canis Minor	Lesser Dog
Ras Alhague	Ophiucus	Serpent Bearer
Regulus	Leo	Lion
Rho Puppis	Puppis	Stern
Rigel	Orion	Orion
Scheat	Pegasus	Pegasus
Sirius	Canis Major	Greater Dog
Spica	Virgo	Virgin
Unukalhai	Serpens	Serpent
Vega	Lyra	Lyre
Vindemiatrix	Virgo	Virgin
Zaurak	Eridanus	River
Zeta Herculis	Hercules	Hercules
Zeta Persei	Perseus	Perseus
Zuben el Genubi	Libra	Balance

8.3 Alignment Star Charts

Use the charts in the following pages to locate the appropriate alignment stars. There are four charts for the northern hemisphere and four charts for the southern hemisphere, each corresponding to a different period of the year. Find the chart corresponding to your hemisphere and to the period of the year, then orient it with the cardinal points.

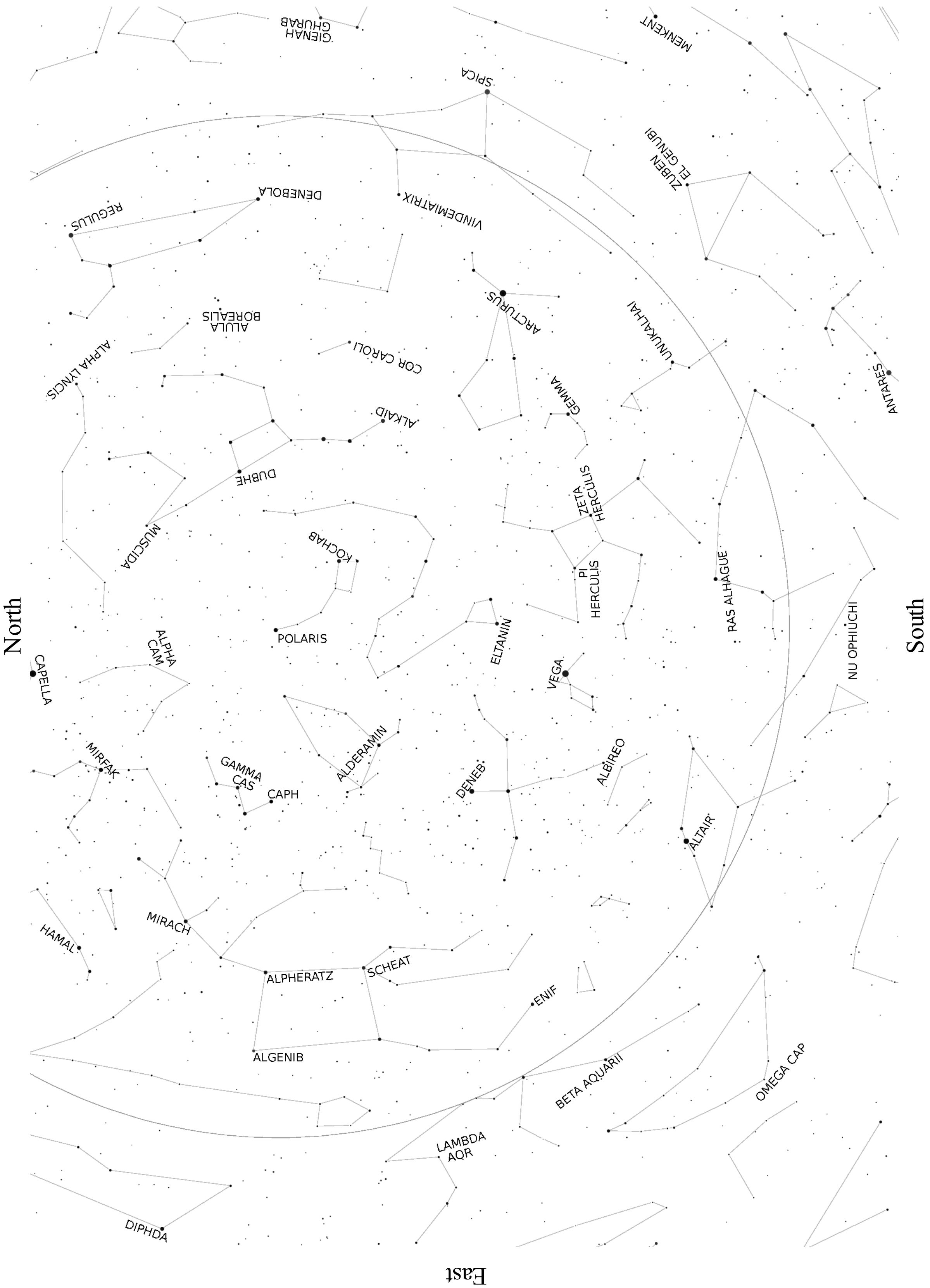
The stars shown for each period of the year are the ones visible in first part of the night; if you are working in different hours, you will have to use another chart. Also, near the equator you may have to use stars both from the northern and the southern hemisphere charts.

Northern Hemisphere Chart – March to May



Northern Hemisphere Chart – June to August

West

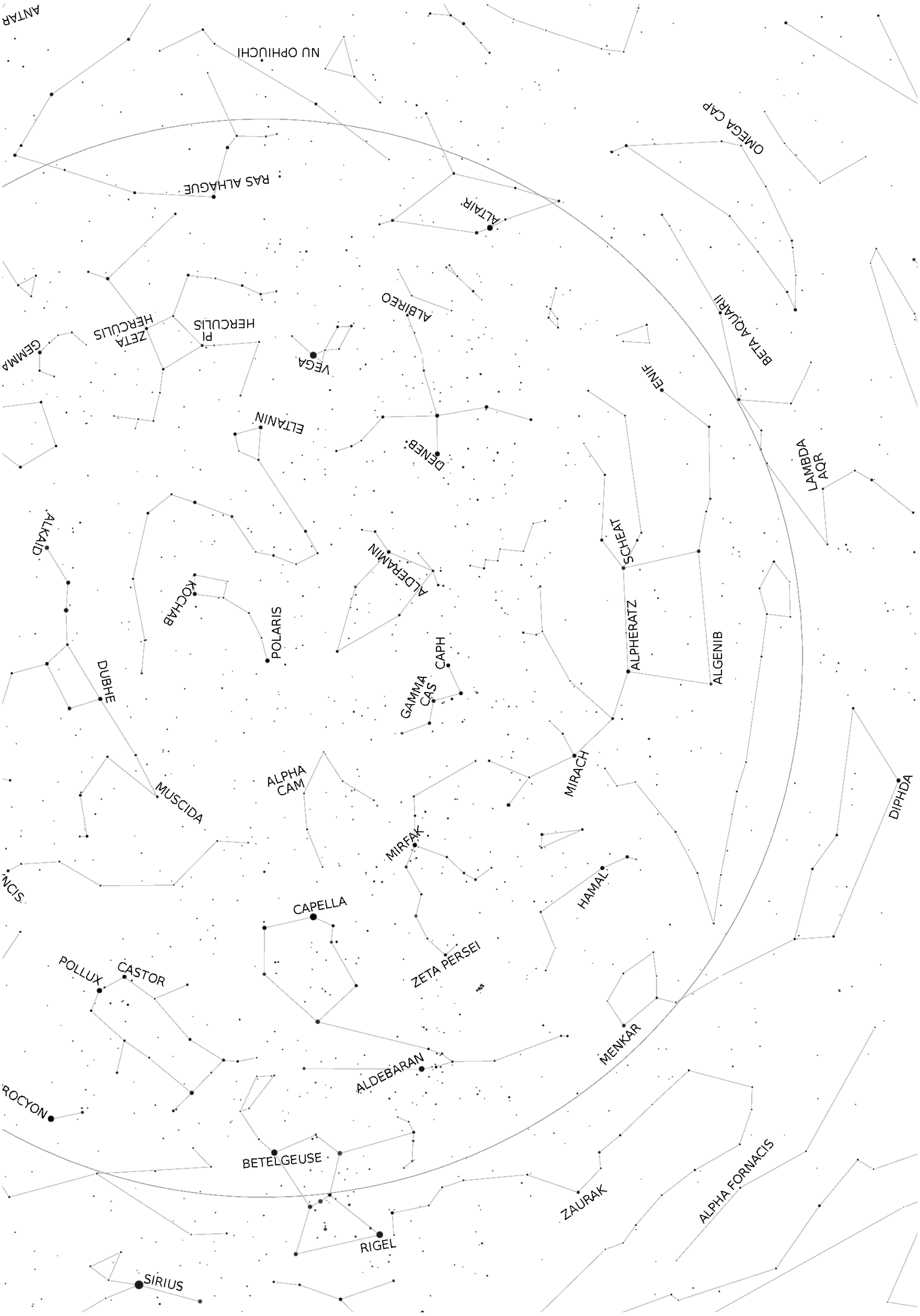


East

Northern Hemisphere Chart – September to November

West

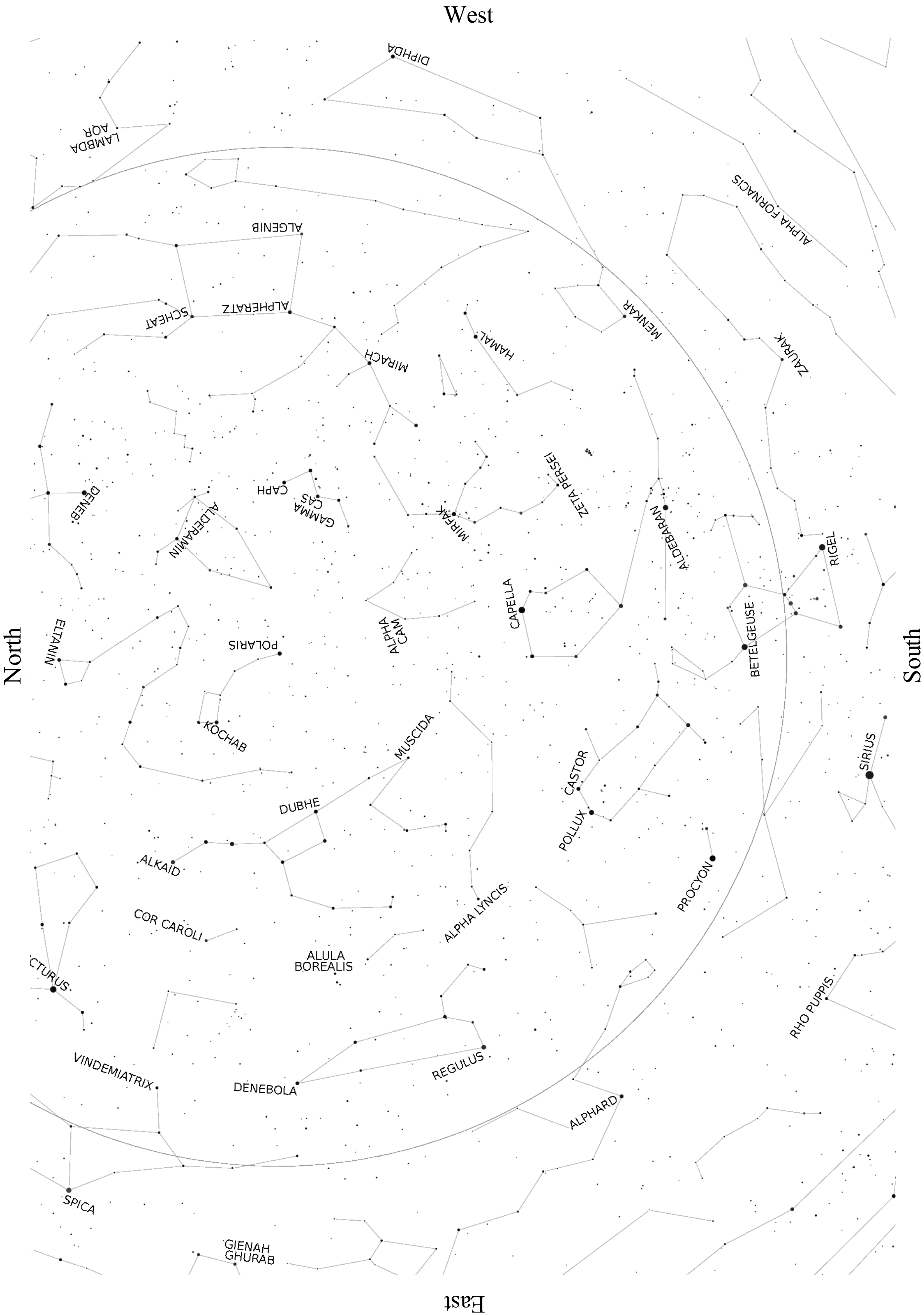
North



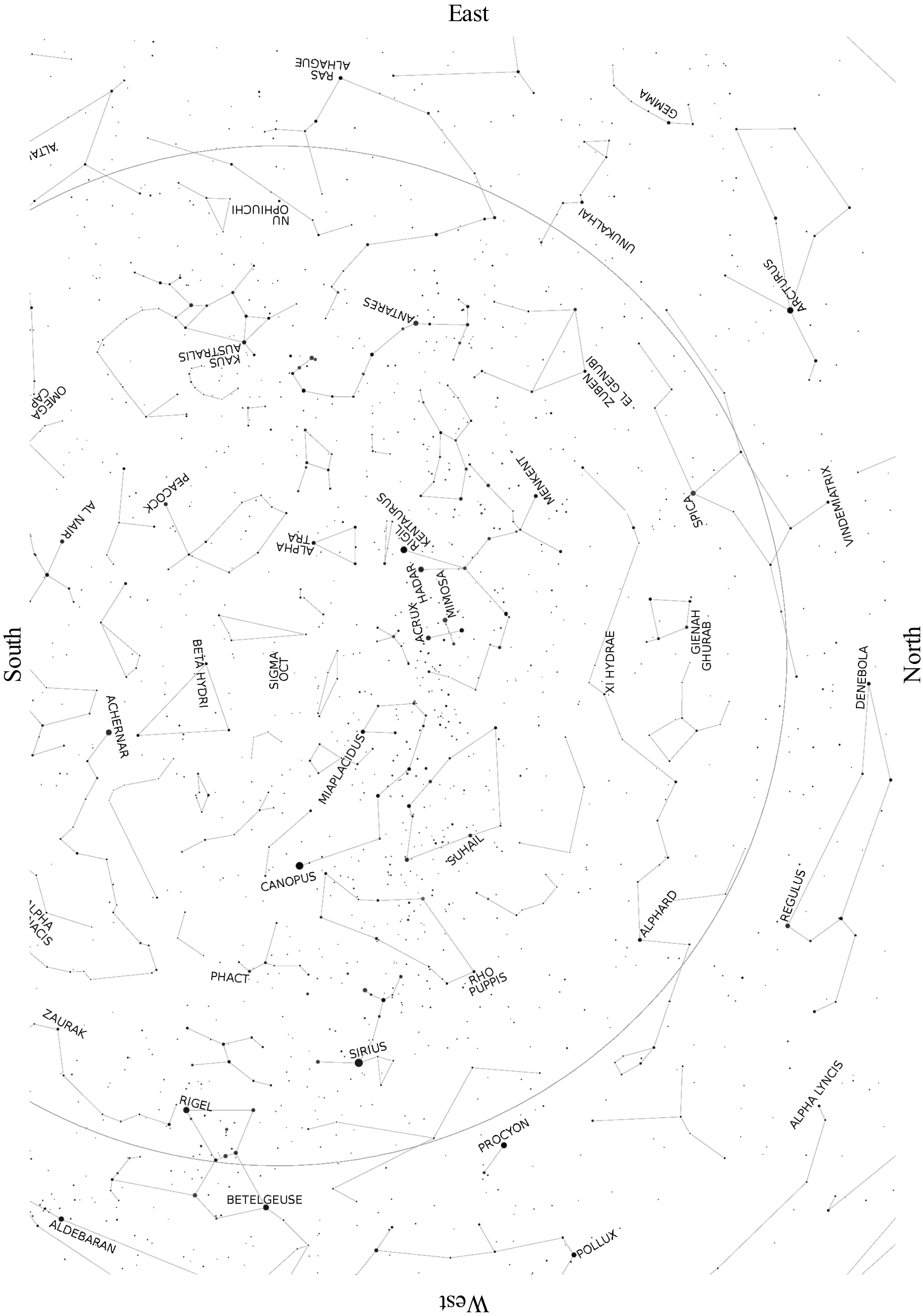
South

East

Northern Hemisphere Chart – December to February



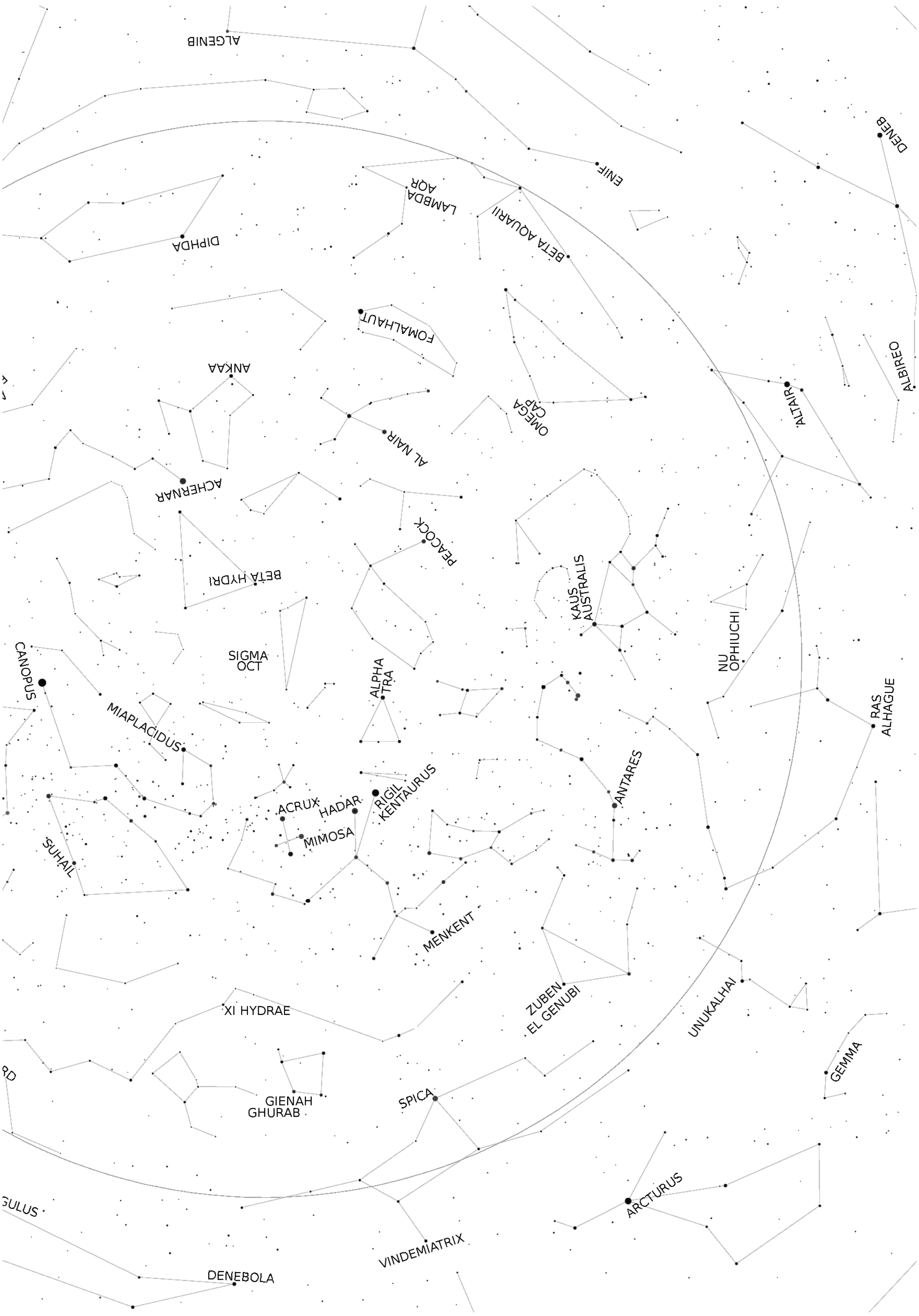
Southern Hemisphere Chart – March to May



Southern Hemisphere Chart – June to August

East

South

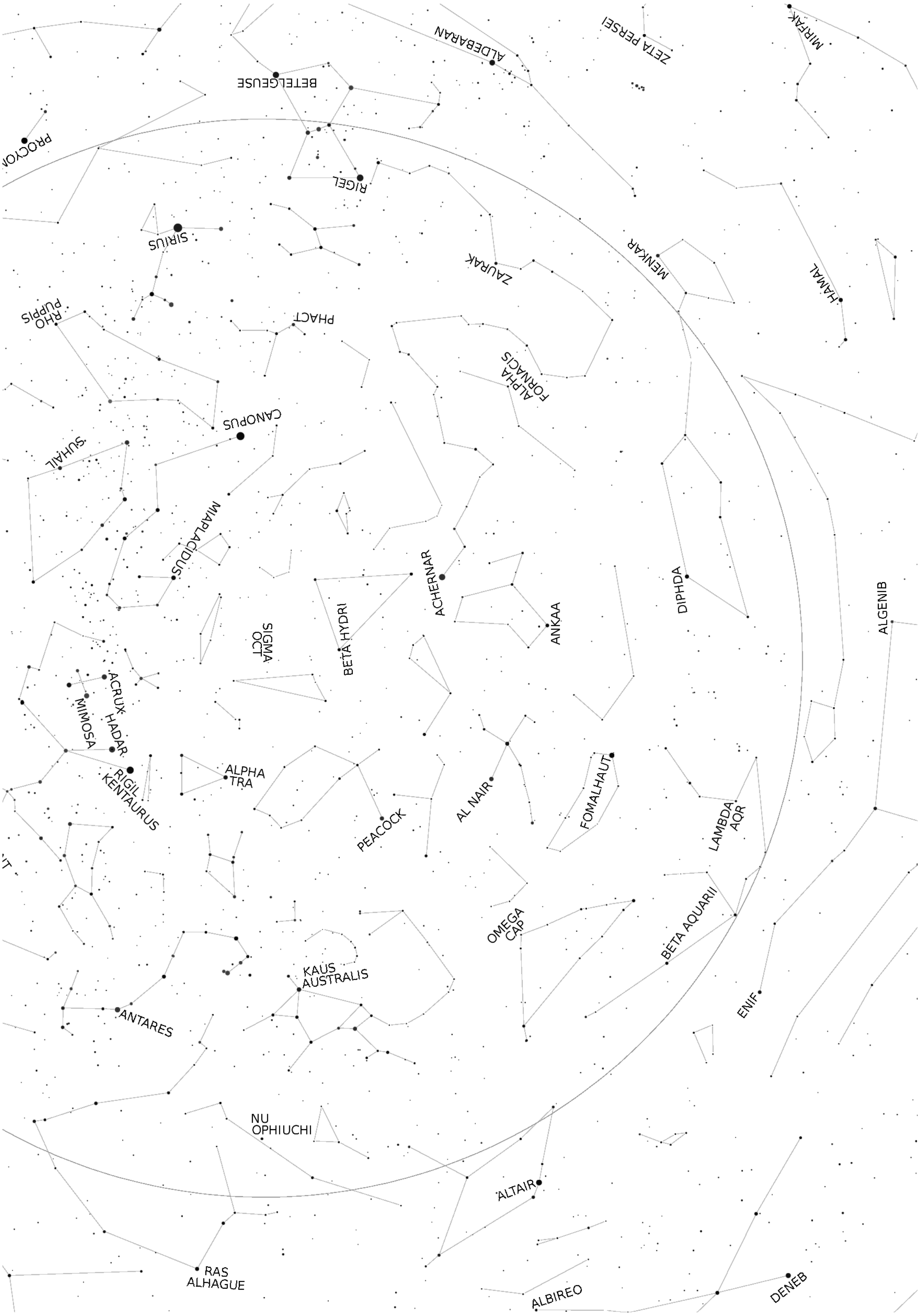


North

West

Southern Hemisphere Chart – September to November

East



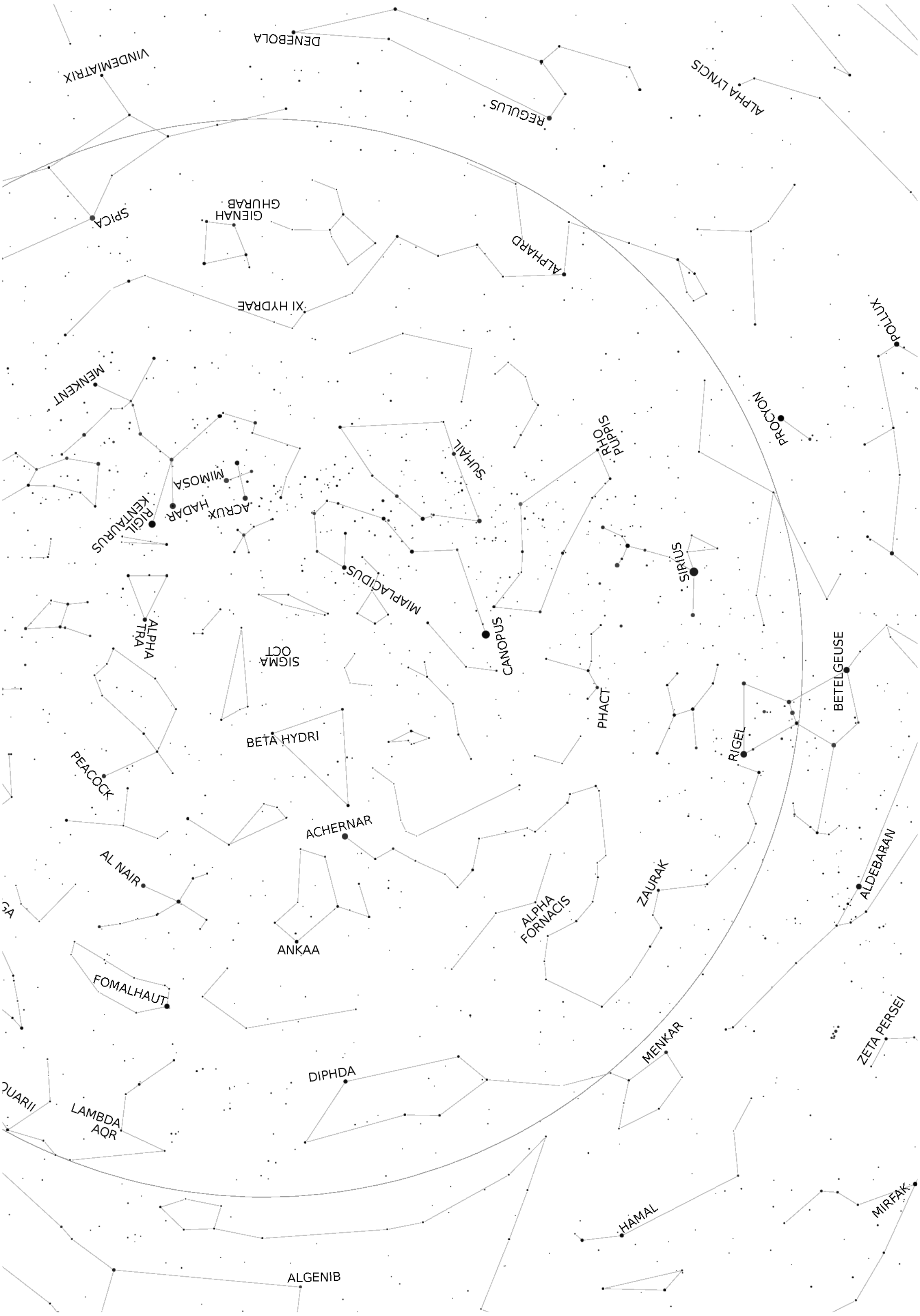
South

North

West

Southern Hemisphere Chart – December to February

East



South North

West

9 Remote Control

The GM4000QCI mount can be controlled from a remote PC in a number of ways. You can use the Virtual Keypad software, provided by 10micron, to emulate the functions of the hand pad, or control the mount with many popular software packages. This can be done through the RS-232 port or the LAN port.

Through these ports you can also upgrade the firmware of the mount.

WARNING

This system does not know if the telescope or some other instrument collides with the mount or other obstructions when moving. The software will slew to the correct side of the meridian (with an user-configurable tolerance), will perform some checks and will disallow aiming under the horizon (with an user-configurable tolerance) *when the alignment has been done correctly*.
You should pay attention when the telescope is moving in order to avoid problems to the telescope, its accessories and cables. Additional care should be used when the mount is operated remotely. In this case, a webcam or surveillance camera could be a good idea to check that everything is OK.

9.1 Configuration

The configuration to use depends on the selected port (RS-232 or LAN). You can also use the GPS port as a serial port, using the provided adapter; in this case the setup is the same as for the RS-232 port.

9.1.1 RS-232 Serial Connection

The serial interface of the PC is connected to the serial interface of the control box, using a pin-to-pin cable (see chapter 5.1.1). No additional configuration is required.

9.1.2 Ethernet – LAN

Various connections are possible. The mount can be inserted into an existing network, connecting the LAN socket of the control box with a switch/router using a CAT.5 pin-to-pin cable (Fig. 9.1).

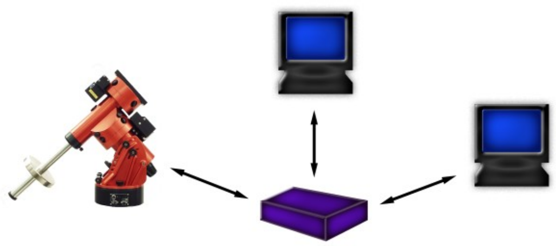


Fig. 9.1: Connecting the mount to a network.

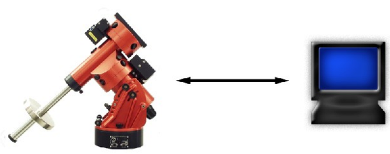


Fig. 9.2: Connecting the mount directly to a PC.

Otherwise, the mount can be connected directly with a PC network socket, using a CAT.5 crossover cable (Fig. 9.2). A standard CAT.5 cable can be up to 100m

long.

If you connect the mount directly to a PC using a crossover cable, you can set both the PC's and the mount's IP addresses as in the following example (assuming using Windows XP – other operating systems may have slightly different ways of configuring the network).

On the PC, click on Start, then select Connect To and Show All Connections. The Network Connections folder opens. Right-click on the Local Area Connection and select Properties. Make sure that the TCP/IP protocol is checked and double click on it. Select "Use the following IP address" and enter IP address "192.168.1.1" and Subnet mask "255.255.255.0".

Then click on OK in this window and in the Properties window, and close the Network Connections folder.

On the Mount, select ***MENU*** – **Settings** – **Network** – **Config Network** – **Set IP Address** and enter the following data:

```
IP address: 192.168.001.099
Network mask: 255.255.255.000
Gateway: 192.168.001.001
```

If you are connecting the mount to a router or an ADSL modem/router where the PC is already connected, often a DHCP server is available to obtain automatically the configuration information. In order to use the DHCP server, select ***MENU*** – **Settings** – **Network** – **Config Network** – **Use DHCP**. The mount will try to obtain the configuration information from the DHCP server. Select ***MENU*** – **Settings** – **Network** – **Show IP address** and scroll the text with the +/- keys to verify the configuration; note the IP address of the mount.

If you are connecting the mount to a pre-existing network with pre-assigned IP addresses, you will have to enter manually an IP address/subnet mask/gateway which is appropriate for your network.

NOTICE

There are many possible network configurations. The above settings are only an example, that may work or not in your particular case.

You can check that the PC and the mount can communicate using the PC command prompt, found under Start – All Programs – Accessories – Command Prompt. Type "ping" followed by your mount's IP address (for example "ping 192.168.1.99" and press Enter. You will see an answer similar to this one:

```
Pinging [192.168.1.99] with 32 bytes of data:
Reply from 192.168.1.99: bytes=32 time<1ms TTL=128
Reply from 192.168.1.99: bytes=32 time<1ms TTL=128
Ping statistics for 208.80.152.2:
  Packets: Sent = 2, Received = 2, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
   Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

If you see "Request timed out" then the connection, or the configuration, is incorrect.

9.2 Controlling the Mount with the Virtual Keypad

The Virtual Keypad software, included in the CD-ROM, simulates a hand pad device on a remote control PC.

To install the software, start the executable installer contained in the file gm_qci_virtkeypad1.x.zip on the CD-ROM.

9.2.1 Operation

On the PC desktop, click on the “Virtual Keypad” icon to start the software. The main window of the Virtual Keypad software (Fig. 9.3) replicates the hand pad.

Click on “Connection” and then on “Settings”. A window appears where you can insert the connection parameters. Depending upon the desired connection mode, either select “Serial on RS-232 port” and choose the appropriate COM port (Fig. 9.4), or select “LAN (TCP/IP)” and enter the TCP/IP address of the mount (Fig. 9.5), available from the hand pad choosing ***MENU*** – **`Settings`** – **`Network`** – **`Show IP address`**. Confirm the configuration clicking on the “OK” button.

NOTICE

When using the LAN connection, the Virtual Keypad software communicates with the mount using the TCP/IP port number 3491.

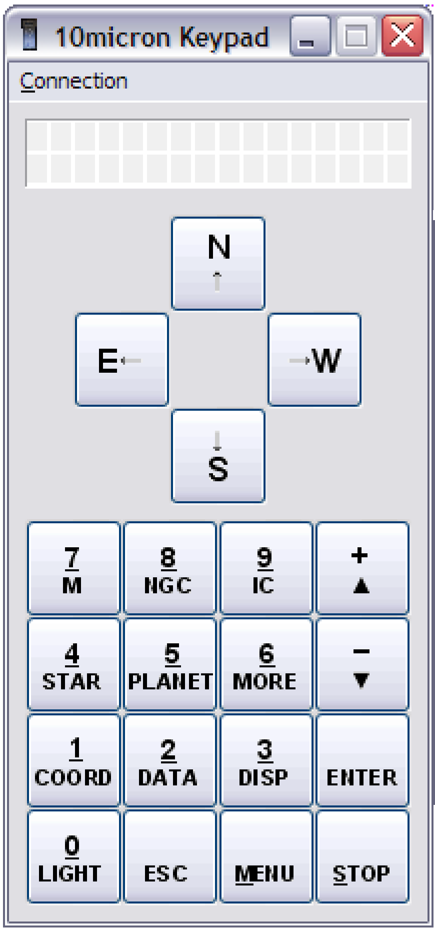


Fig. 9.3: Virtual Keypad software.

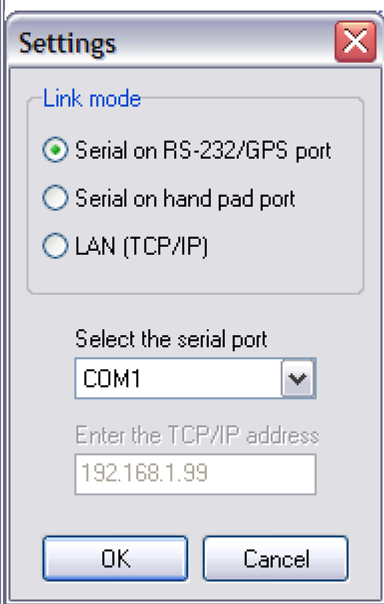


Fig. 9.4: Settings for serial connection.

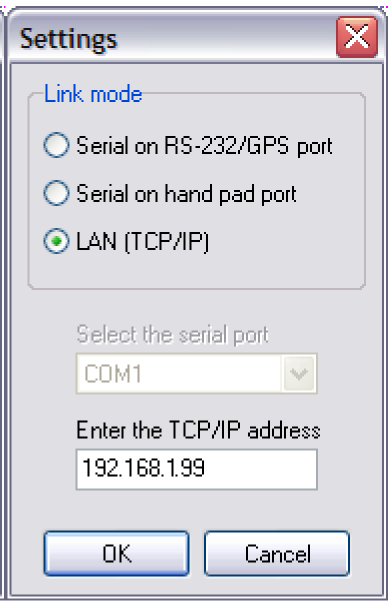


Fig. 9.5: Settings for LAN connection.

Now click on “Connection” and then on “Connect”. The connection is established, and the display of the Virtual Keypad software will be updated to reflect the current display of the hand pad.

The hand pad and the Virtual Keypad operate in parallel, i.e. the display is the same on both devices and pressing a key on the Virtual Keypad has the same effect as pressing a key on the hand pad.

The keys of the Virtual Keypad can be pressed by clicking on them with the mouse, or by typing on the keyboard with the following correspondence:

Key on Virtual Keypad	Key on keyboard
N ↑	cursor up
E ←	cursor left
W →	cursor right
S ↓	cursor down
ESC	Esc
MENU	M
STOP	S
ENTER	Enter
+ ▲	+ or Page Up
– ▼	– or Page Down

Key on Virtual Keypad	Key on keyboard
0 – LIGHT	0
1 – COORD	1
2 – DATA	2
3 – DISP	3
4 – STAR	4
5 – PLANET	5
6 – MORE	6
7 – M	7
8 – NGC	8
9 – IC	9

To interrupt the connection, click on “Connection” and then on “Disconnect”. You can then remove the LAN cable or the serial cable.

9.3 Controlling the Mount with Other Software

The GM4000QCI mount can communicate with other software by emulating the LX200 or Astrophysics GTO protocols (see paragraph 6.5.3 for details about selecting the protocol), using the RS-232 port and the GPS port, and also on the TCP/IP ports 3490 and 3492.

If you want to use the Ethernet connection over port 3490 or 3492 with a software supporting the LX200/Astrophysics protocol over a serial link, you can use a virtual serial port software such as HW Virtual Serial Port (http://www.hw-group.com/products/hw_vsp/index_en.html).

The following notes, regarding some software packages, are provided as a quick reference only; see the documentation included with your software for details about its telescope control functions.

9.3.1 Note for GUIDE 6.0 / 7.0 / 8.0

Read carefully the paragraph of the GUIDE manual that describes the control of an instrument through GUIDE.

Select "LX200 Meade" as the communication protocol and select the serial port where the mount has been connected. The serial transmission speed is 9600 bps.

9.3.2 Note for "The Sky"

Start "The Sky" and choose from the menu "Telescope→Setup". Choose "LX200 Meade" as telescope type (if you have selected the Astro-Physics emulation on the hand pad, you should choose "Astro-Physics GTO" as telescope type).

Now go to the Settings menu, insert the serial port where the mount has been connected at "COM Port" and set the baud rate to 9600. This is required only for the first connection.

Select "Telescope→Link" from the menu and click "Establish".

TheSky will show you the area where the telescope is just pointing at.

Now "The Sky" is able to control the mount.

If you get the error message "LX200 not responding..." please check if you used the correct serial port, if the port is set correctly, if the cable is connected at both ends and if the electronics is switched on.

Now if you click at an object on the screen an "Object information" window will appear. If you click on the small telescope icon the telescope will slew to this object.

If you want to fine centre this object you can click on "Telescope/Motion controls". Using the buttons in the small "Motion Control" window you can move the telescope in all directions.

NOTICE

If you decide to use the “T-Point” function of TheSky, we suggest that you don’t make an alignment with 2 or more stars, because the mount calculations may interfere with the corrections made by “T-Point” resulting in bad pointing situations and errors.

9.3.3 Note for "Perseus"

Start "Perseus" and choose from the menu "Telescope control"; select "LX200 Meade" as telescope type (if you have selected the Astro-Physics emulation on the hand pad, you should change it back to LX200).

Choose the serial port where the mount has been connected.

Now the control window will appear and "Perseus" is able to control the mount.

9.3.4 Note for ASCOM compatible software (Maxim DL, ACP and others)

The GM4000QCI mount is compatible with software supporting the ASCOM specification (see the website http://ascom-standards.org). It should be controlled like an LX200 (Meade LX200, not generic) with no additional settings, or using the Astrophysics GTO drive with the Astrophysics protocol emulation.

NOTICE

Because of the rapid change of the software industry, the compatibility with the GM4000QCI mount changes continuously.
For information about the command set supported by the RS-232 link, please contact the assistance at support@10micron.com or the authorised reseller.

9.4 Upgrading the Firmware

The firmware of the GM4000QCI mount can be upgraded to a new version using the updater software, available from the 10micron website.

To download the updates, go to the URL www.10micron.com/english/support.htm and click “Forum”.

You need to register to the forum to download the updates.

The updater software can also be used to update the comets and asteroids databases of the mount.

The instruction manual for the updater is available as a .PDF file after installing the software. Please refer to it for details.

10 Troubleshooting

The software of the GM4000QCI mount has been carefully tested by several experts. If you still find an error, please tell us. In that case, we need the following information from you:

1. The version number of the software, displayed under ***MENU*** – **`Settings`** – **`Version`**.
2. A complete list of all adjusted parameters.
3. A detailed description of how to reproduce the error. A problem can only be resolved if it is reproducible.

If you have a proposal for improving the GM4000QCI mount, please let us know, also by e-mail at support@10micron.com.

A table of commonly encountered problems (and proposed solutions) follows.

Problem	**Cause**	**Action**
The telescope can't slew accurately to an object.	The polar axis is not correctly aligned with the celestial pole.	Repeat the alignment procedure or use the 2-stars alignment.
	The wrong object has been selected.	Select the correct object.
	The telescope has been aligned on the wrong stars.	Repeat the alignment procedure.
	Some parameters (date, time, location, time zone, DST) are not correctly set.	Enter the correct parameters.
	The telescope has a large orthogonality error and the mount has been aligned only with 2 stars or less.	Repeat the alignment using three or more stars.
The motors halt and the “MOTOR ERROR – CHECK POWER” message appears.	The power supply is inadequate.	Check that the power supply is able to provide the required current (5A) at 24V DC.
	The mount has hit the mechanical stops.	Repeat the alignment procedure.
The telescope hits an obstacle or the base of the mount.	The alignment is incorrect.	Repeat the alignment procedure.
	The Flip Slew Tolerance and Flip Guide Tolerance parameters are set to a value that is too large.	Set the Flip Slew Tolerance and Flip Guide Tolerance to a smaller value.
The message “Last session shutdown error” appears when switching on the mount.	The power supply has been removed before the completion of the shutdown.	When switching off the mount, wait until the red led turns off before removing the power supply.

11 Maintenance

Under normal operating conditions, minimal maintenance is required.

Every 12 months clean the external surfaces from dust and, if you want, lightly grease all surfaces with a soft cloth to protect the surface colour treatment of the mount. We recommend using Vaseline oil.

Remove humidity.

The internal parts are greased for the entire life of the mount and, under normal operating conditions, no other maintenance is required. After 10 years you can think to do a total maintenance of all internal gearing, but we suggest to do it with an expert or if you prefer by our maintenance department.

No checks or periodical corrections are needed.

12 Technical Support Centre

If any problem occurs, please don't hesitate to contact the reseller or dealer in your country or directly our technical support department, also on our web site at:

www.10micron.com/english/support.htm

Don't hesitate to contact us for assistance:

10 MICRON by

COMEC company – via Archimede 719

21042 Caronno Pertusella (VA) ITALY

For foreign countries:

For any technical or maintenance problem or problems regarding spare parts, please contact the manufacturer or authorized dealer in the country of import, who will tell you what steps to take or will refer you to qualified maintenance centres.

WARNING

The company cannot be held responsible for any damage caused by operations effected by staff who have not first contacted the Technical Assistance Centres or who have not been authorized by the manufacturer's assistants.

The warranty and CE conformity declaration are included in the mount package.

13 Menu Structure

Use this reference table to find the relevant information for each command in the menu of the hand pad.

The main menu is composed of five items: Objects – Alignment – Drive – Local Data – Settings.

13.1 Objects

Menu	Submenu	Notes	Paragraph
Deepsky	Messier	Messier catalogue	6.1.1
	NGC	**N**ew **G**eneral **C**atalogue	6.1.1
	IC	**I**ndex **C**atalogue	6.1.1
	PGC	**P**rincipal **G**alaxy **C**atalogue	6.1.1
	UGC	**U**ppsala **G**eneral **C**atalogue of galaxies	6.1.1

Menu	Submenu	Notes	Paragraph
Star	Name	Proper name	6.1.2
	Bayer	Bayer letter and constellation	6.1.2
	Flamsteed	Flamsteed number and constellation	6.1.2
	BSC	**B**right **S**tar **C**atalogue (also HR, **H**arvard **R**evised)	6.1.2
	SAO	**S**mithsonian **A**strophysical **O**bservatory	6.1.2
	HIP	**Hi**pparcos **C**atalogue	6.1.2
	HD	**H**enry **D**raper catalogue	6.1.2
	PPM	Position and **P**roper **M**otions catalogue	6.1.2
	ADS	**A**itken **D**ouble **S**tar catalogue	6.1.2
	GCVS – letter – number	**G**eneral **C**atalogue of **V**ariable **S**tars	6.1.2

Menu	Submenu	Notes	Paragraph
Planet	0 Sun		6.1.3
	1 Mercury		6.1.3
	2 Venus		6.1.3
	3 Moon		6.1.3
	4 Mars		6.1.3
	5 Jupiter		6.1.3
	6 Saturn		6.1.3
	7 Uranus		6.1.3

	8 Neptune		6.1.3
	9 Pluto		6.1.3

Asteroid	1 Ceres 2 Pallas ...	Select from the list or enter the official number.	6.1.4

Comet	1P Halley 2P Encke ...	Select from the list or enter the official number.	6.1.5

Coordinates		Enter RA and declination coordinates to slew to	6.1.6

User defined	Select user obj.	Select an object from the user database	6.1.7
	Add user obj.	Add an object to the user database	6.1.7
	Delete user obj.	Delete an object from the user database	6.1.7

Alt/Az Coords.		Enter altazimuth coordinates to slew to	6.1.8

Meridian Flip		When in the proximity of the meridian, moves the telescope to the other side of the mount, pointing at the same point in the sky	6.1.9

Satellite	Satellite Find	Select a satellite from the list	6.1.10
	Next passes	Select a satellite passing in the next minutes	6.1.10

13.2 Alignment

Park/Unpark		Park or unpark the mount	5.6

Park position	Stops only	Parking stops the mount in the current position	6.2.2
	Default park	Parking slews the mount to the default park position	6.2.2
	Custom park 1	Parking slews the mount to the custom park position 1	6.2.2
	Custom park 2	Parking slews the mount to the custom park position 2	6.2.2

	Custom park 3	Parking slews the mount to the custom park position 3	6.2.2
	Set custom pos1	Set the current position as the custom park position 1	6.2.2
	Set custom pos2	Set the current position as the custom park position 2	6.2.2
	Set custom pos3	Set the current position as the custom park position 3	6.2.2

Polar Iterate		Align the polar axis using Polaris and another star	5.5.5

2-Stars		Align the mount using two stars as reference objects	5.5.1

Refine 2-Stars		Add a star as reference object for calibrating the mount	5.5.3

3-Stars		Align the mount using three stars as reference objects	5.5.2

Align Database	Load model	Save the current alignment in the database	6.2.7
	Save model	Load an alignment from the database	6.2.7
	Delete model	Delete an alignment from the database	6.2.7

Reset at Home		Initialize the mount at the home position	5.4.1

Polar Align		Align the polar axis using the alignment data and without Polaris	5.5.4

Ortho Align		Correct the orthogonality error of the telescope	5.5.6

Align Info		Show various data on the current alignment	5.5.8

Home Search		Slew the mount to the home position and recover the previously saved alignment data from the memory	5.5.7

Home Save		Slew the mount to the home position and	5.5.7

		save the current alignment data to the memory.	

Boot Align	Alw. Home	Go to the home position and retrieve the saved alignment data when the mount is switched on	6.2.14
	Alw. Unpark	Unpark the mount when it is switched on, even if it has been switched off in parked status	6.2.14

13.3 Drive

Tracking Speed	Sidereal	Sidereal tracking speed	6.3.1
	Solar	Solar tracking speed	6.3.1
	Lunar	Lunar tracking speed	6.3.1
	Custom	Custom tracking speed, entered by the user	6.3.1
	Stop	Tracking stopped	6.3.1

A-PEC control	No A-PEC	Periodic error correction switched off	6.3.2
	A-PEC Active	Periodic error correction active	6.3.2
	A-PEC Training	Training of the periodic error correction function	6.3.2

Dual tracking		Activate dual axis tracking.	6.3.4

Swap E-W		Exchange the action of the E – W direction keys	6.3.4

Swap N-S		Exchange the action of the N – S direction keys	6.3.5

Auto Swap N-S		Exchange automatically the action of the N – S direction keys, depending on the meridian side.	6.3.6

Corr. Speed		Activate the $\cos h^{-1}$ correction for manual movements and autoguiding	6.3.7

Slew Rate		Set the maximum slew speed, between 2°/s and 5°/s	6.3.8

Autoguide speed		Sets the autoguide correction speed.	6.3.9

Tracking corr.		Set a correction to the tracking speed	6.3.10

Backlash		Set the amount of backlash correction	6.3.11

Stiction comp.		Set the amount of stiction compensation	6.3.12

Flip Slew Tol.		Define the angular limit to which the telescope will slew going beyond the meridian from the “wrong” side of the mount (max. 15°, default 10°)	6.3.13

Flip Guide Tol.		Define the angular limit to which the telescope will track objects beyond the meridian (max. 15°, default 15°)	6.3.14

Horizon Limit		Set the minimum elevation for slews, from -5° to +90°	6.3.15

Track warn.		If this option is active, beeps when the tracking time left is expiring.	6.3.16

Follow Obj.		Set to ON to compute and set automatically the tracking rate after each slew to a solar system object	6.3.17

Balance RA		Swings the telescope up and down to verify balancing (RA axis)	6.3.18

Balance Dec		Swings the telescope up and down to verify balancing (Dec axis)	6.3.19

13.4 Local Data

Clock	Date and Time	Enter the date and time	6.4.1
	Local Timezone	Set the local time zone (positive east of Greenwich)	6.4.1
	DST	Daylight Saving Time correction	6.4.1

Site	Current	Show the current observation site data	6.4.2

	Select	Select the observation site from the database	6.4.2
	Enter	Enter the coordinates of the observation site	6.4.2
	Save	Save the current observation site in the user database	6.4.2
	Delete	Delete an observation site from the user database	6.4.2

Get GPS Data		Get date, time and geographical coordinates from the optional GPS module	6.4.3

Boot GPS Sync		Search the optional GPS module when the mount is switched on	6.4.4

Refraction	Show Current	Show the current refraction data	6.4.5
	Set Temperature	Enter the air temperature	6.4.5
	Set Pressure	Enter the atmospheric pressure in hPa	6.4.5
	Set Pressure 0	Enter the atmospheric pressure at sea level in hPa	6.4.5
	Auto Press.	Compute the pressure from elevation	6.4.5

13.5 Settings

User Interface	Brightness	Set the brightness of the display (Maximum, High, Medium, Low or Minimum)		6.5.1
	Contrast	Set the contrast of the display (Maximum, High, Medium, Low or Minimum)		6.5.1
	Beep	Activate or deactivate the sound from the virtual keypad		6.5.1
	Boot Display	Select what to display after switching on the mount		6.5.1
		RA/Dec Coord.	Equatorial coordinates	6.5.1
		Alt/Az Coord.	Altazimuth coordinates	6.5.1
		Lcl Time Clock	Local time	6.5.1
		UTC Clock	Universal Time	6.5.1
		Chrono	Stopwatch	6.5.1
		Timer	Countdown timer	6.5.1

GPS Port	GPS	Use the GPS port to get data from a GPS	6.5.2

	Serial	Use the GPS port as an auxiliary RS-232 port	6.5.2
	Dome	Use the GPS port for dome control	6.5.2

Emulation	Emul. LX200	Emulate the LX200 protocol	6.5.3
	Emul. AP	Emulate the Astrophysics protocol	6.5.3

Network	Show IP address	Show the current network configuration		6.5.4
	Config Network	Enter the network configuration		6.5.4
		Use DHCP	Use a DHCP server	6.5.4
		Set IP address	Set manually the IP address, network mask and gateway	6.5.4

Asteroid Filter	Filter	Activate or deactivate the asteroid brightness filter	6.5.5
	Limit magnitude	Set the magnitude limit for the asteroid filter	6.5.5

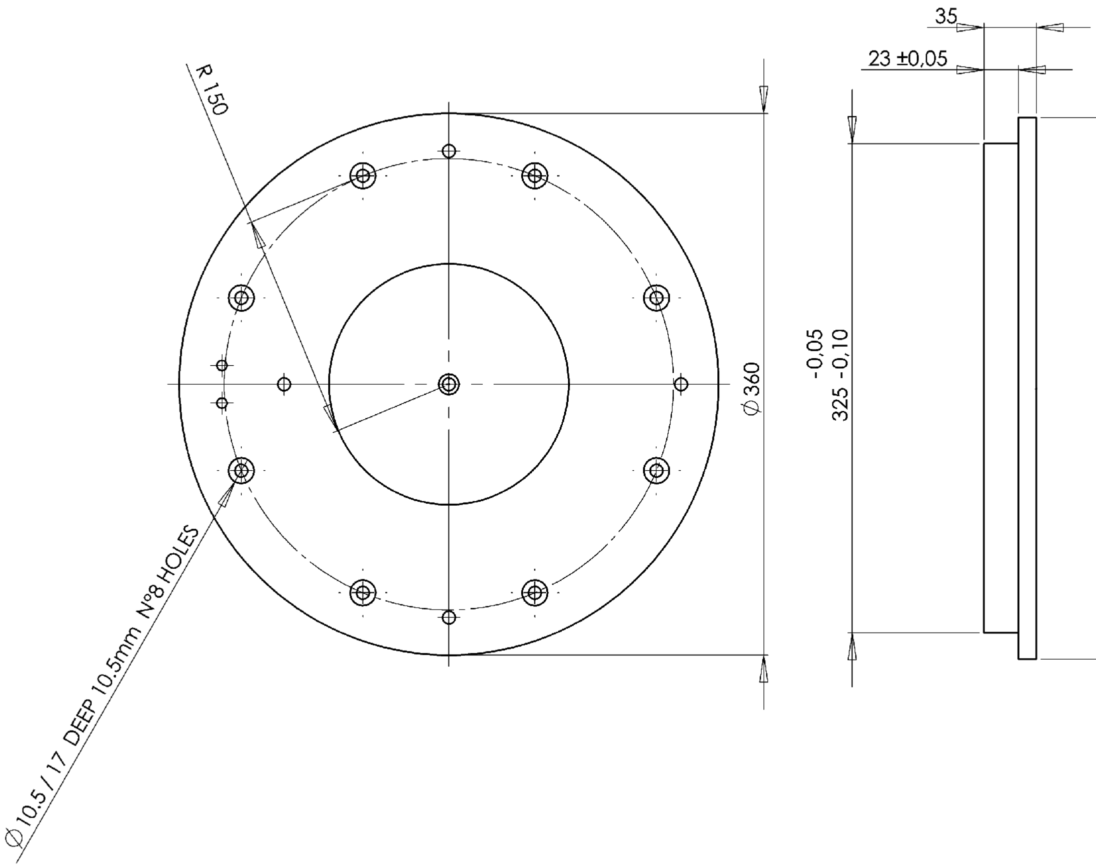
Comet Filter	Filter	Activate or deactivate the comet brightness filter	6.5.6
	Limit magnitude	Set the magnitude limit for the comet filter	6.5.6

Dome	Open Shutter	Open the dome shutter	6.5.7
	Close Shutter	Close the dome shutter	6.5.7
	Home	Force homing of the dome	6.5.7
	Dome Control	Dome control parameters	6.5.7
	Mount Type	Mount type	6.5.7
	Mount Position	Mount position parameters	6.5.7
	Scope Offset	Scope position parameters	6.5.7

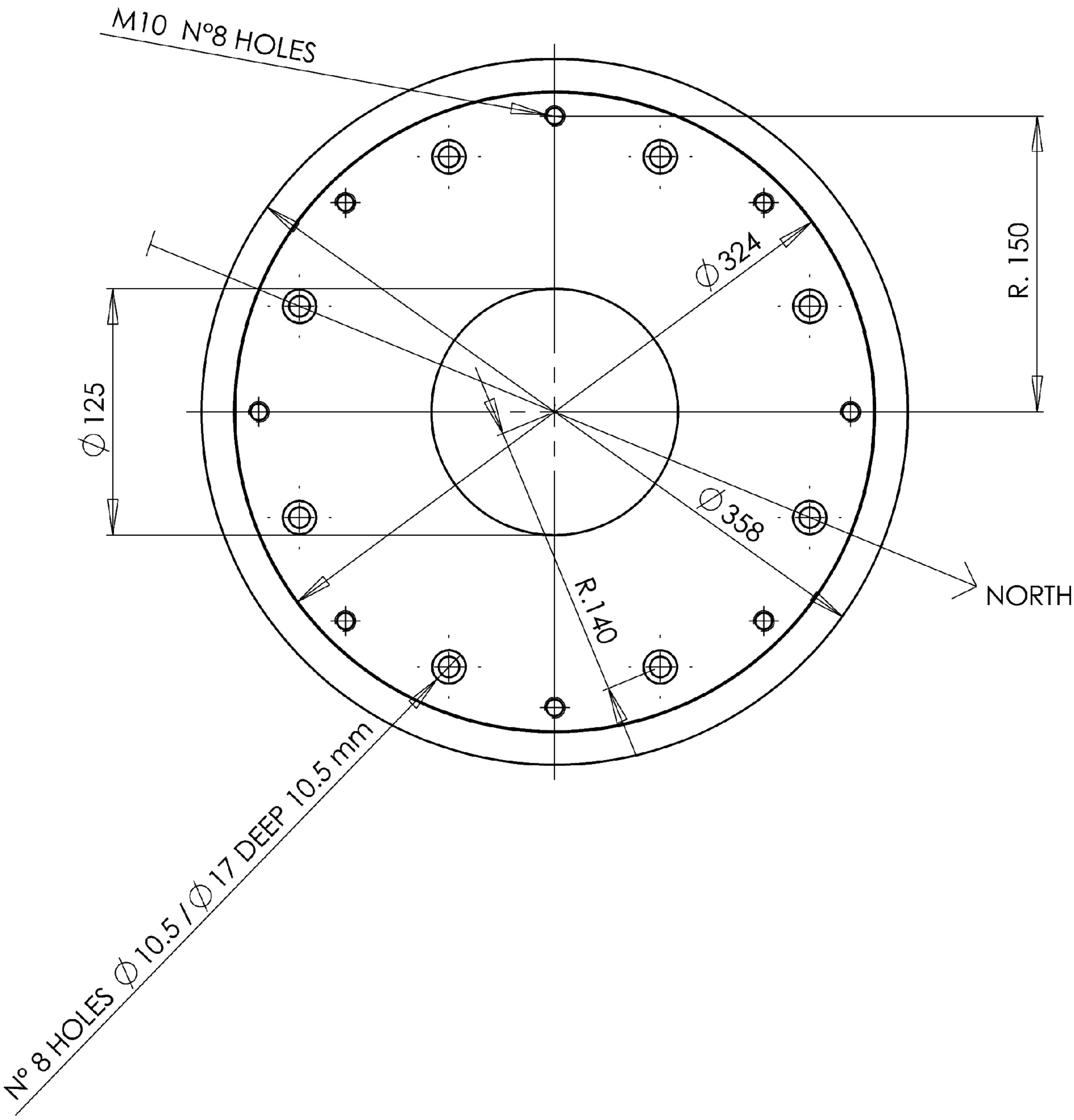
Version		Show the version and date of the firmware, and the version of the motors' firmware	6.5.8

Language		Change the language used on the keypad	6.5.9

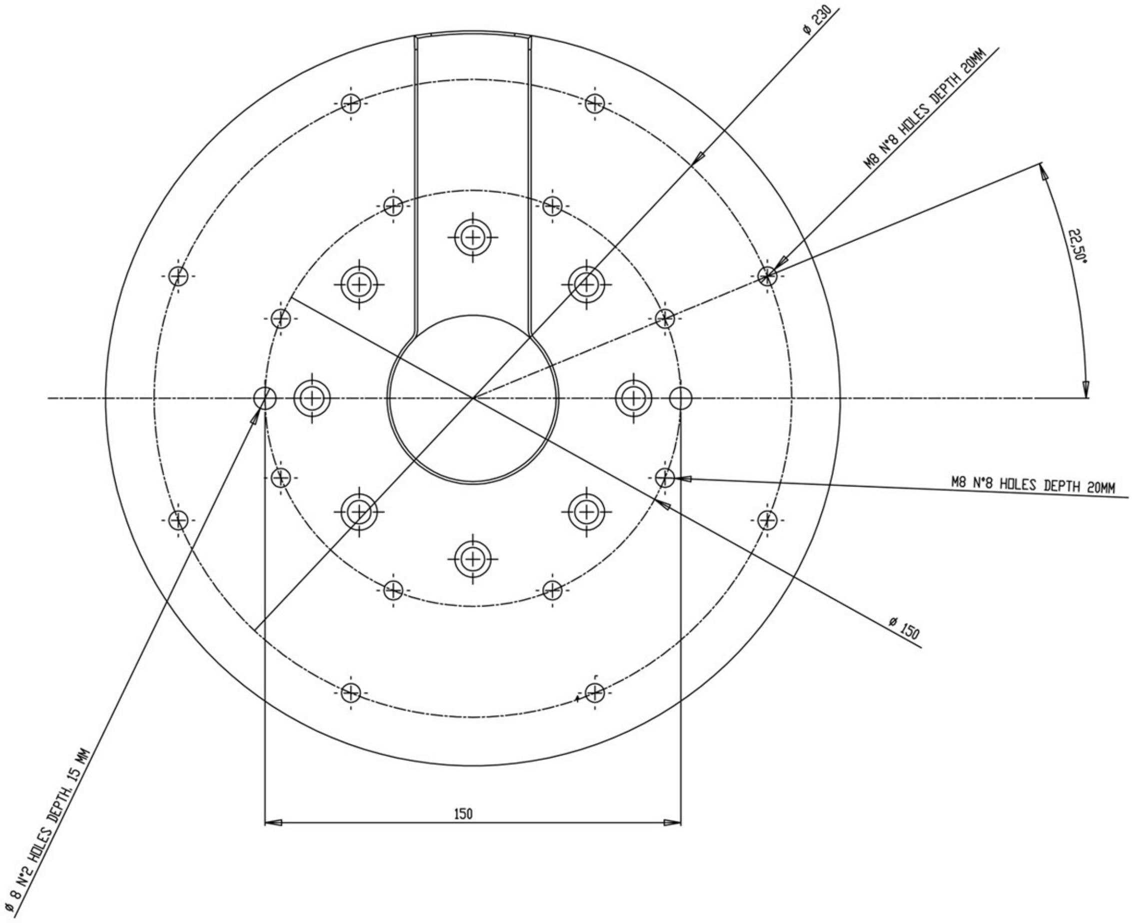
Appendix A Base Adapter



Appendix B Pier Adapter (optional)



Appendix C Telescope Flange



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